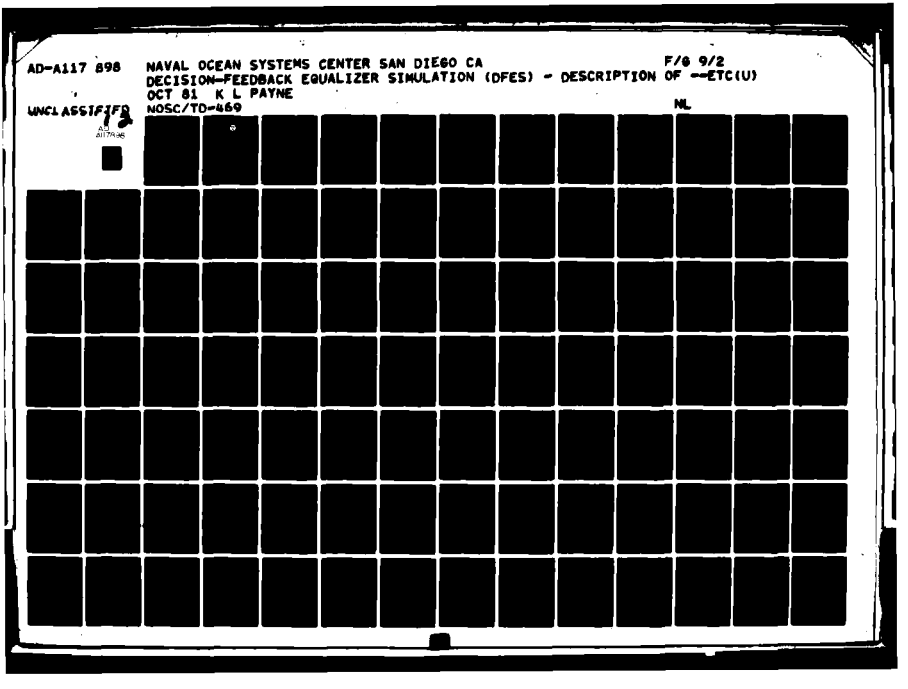
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Technical Document 469

DECISION-FEEDBACK EQUALIZER SIMULATION (DFES) - DESCRIPTION OF VARIABLES

KL Payne
RF & Acoustic Communications Technology Branch
(Code 8112)

October 1981

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This document lists and describes the usage of the variables in the Decision-Feedback Equalizer Simulation (DFES) program which was written for the Naval Ocean Systems Center by Signatron, Inc.

The DFES program can transmit QPSK or BPSK through an hf channel. The channel can have fading, doppler and multipath. The transmission can be received and demodulated by a Decision-Feedback Equalizer with one of four weight update algorithms: Kalman, LMS, fixed, and Rake.

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INTRODUCTION

The Decision-Feedback Equalizer Simulation (DFES) program is written in FORTRAN. It simulates LMS (Least Means Squares), Kalman, Rake, and fixed tap versions of high frequency radio channel equalizers. Considerable interest in this program has been shown by other Government laboratories, industry, and universities. It was felt necessary to preserve the following information on DFES in this publication in order to ease the use and/or modification of this complex program by future users.

The material herein includes basic information on every variable in DFES including:

1. Alphabetically arranged descriptions of all variables.
2. Page numbers from the "Program Performance Specification" where more information on each variable may be found.
3. A tabular listing of all variables indicating which subprograms and routines set, use, or output each variable.
4. A listing of subroutines and functions and where they are used in the program.

This document is useful for identifying and locating variables when modifying and/or debugging the program.

In the following sections, DFES refers to the main program which precedes the initialize parameters subprogram.

DFES SUBPROGRAMS

DFES

Initialize Parameters

Update Input

Channel

Interpolator

Noise Filter

Forward Filter

Compressor

Detector

Differential Decoder

FUNCTIONS

ABS

AIMAG

ALOG

ALOG10

AMOD

CABS

CEXP

CMPLX

CONJG

COS

DEXP

ERFC

EXIT

EXP

FLOAT

IABS

MOD

RAN

REAL

SIGN

SIN

SINC

SQRT

SUBROUTINES - WHERE THEY ARE CALLED

Subroutine	Where Called
BFILT	detector
DPGEN	detector, Sync, Key
FWATE	detector
GAURAN	channel, Noise
KEY	compressor, Sync
MAX	Sync
NOISE	channel
PIN1	initialize parameters
SEMUL	initialize parameters
SINC	update input
SYNC	noise filter
TAPER	channel

FUNCTIONS – WHERE THEY ARE USED

Function	Where Used
ABS	differential decoder, function sinc
AIMAG	detector, differential decoder, Fwate, Bfilt, Taper (Rgen)
ALOG	Gauran
ALOG1Ø	detector, differential decoder, Semul
AMOD	update input, detector, differential decoder, Parin, Fwate
CABS	channel, differential decoder, noise filter, forward filter, detector, Bfilt, Fwate, Sync, Max
CEXP	channel, noise filter
CMPLX	channel, noise filter, detector, Sync, Fwate, Bfilt, Dpgen, Noise
CONJG	noise filter, detector, differential decoder, Sync, Fwate, Bfilt, Key
COS	Gauran
DEXP	function ERFC
ERFC	function subroutine
EXIT	function subroutine, differential decoder, Sync, Bfilt, Parin
EXP	Semul
FLOAT	forward filter, detector, differential decoder, Taper (Read), Fwate, Semul, Pinl, Parin, Sync
IABS	Sync
MOD	Sync, Pinl, Parin
RAN	Gauran
REAL	detector, differential decoder, Fwate, Bfilt
SIGN	detector, Fwate, Bfilt
SIN	function Sinc, Gauran
SINC	function Sinc
SQRT	initialize parameters, channel, detector, Noise, Sync, Gauran

DECISION FEEDBACK EQUALIZER SIMULATION (DFES) PROGRAM (FORTRAN)

1. A

local variable — pages (3-14, 3-45, 3-52, 3-67)
Set DFES
set & used detector
output differential decoder — Set & used Gauran
Set & used Sync — Set & used Taper (Rgen)

A = Transmitted PSK digit (Complex, ARG)

A = (1., 1.) set in DFES

The transmitted PSK digit is then formed by the detector as

A = D

A = D*EJ*A1 if LTAPE = 1

Gauran sets A to

A = RAN (NRAN1, NRAN2)

Taper (Rgen) sets

A = D

2. A

array — pages (3-99, 3-100)
set & used ERFC
used Max

A = Complex array of N elements

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3. A1

local variable
set DFES
used noise filter
set & used detector
set & used Sync

pages (4-1 back, 3-14, 3-65, 3-67, 3-81)
set & used Sinc
set & used Taper (Rgen)

Previous PSK Digit at Transmitter

A1 is the complex previous transmitted PSK digit after encoding used by SNYC to differentially encode its present PSK digit A obtained from DPGEN when IDEC=1.

A=A*A1*EJ

where EJ=(1+j)/2

The encoded A is then stored in A1 for the next iteration. When the acquisition decision is made, the latest value of A1 is stored in AHAT1 as the previous detected PSK digit for the first iteration (NUM=1) pass through the Detector and Differential Decoder. A1 is updated by SYNC for NA bit symbol iterations.

A1 is set in DFES to

A1 = (1.Ø, 1.Ø)

Sinc sets A1 to *The detector sets A1 to A1 = A*

A1 = ABS(PIX)

4. A2

local variable
set & used Sinc

A2 is set in Sinc as

A2 = ABS (SIN (PIX))

5. AC

local variable
set & used channel

AC = 2(1-EC)EDC

6. ADATA

local variable pages (3-82)
set & used Sync

ADATA is the modulation PSK symbol

Sync sets ADATA to

ADATA = CONJG(A)

7. ADR

local variable
set & used Max

ADR is set in MAX as

ADR = CABS (A(MSET(I)))/CABS(A(MSET(1)))

8. AERR

local variable
set DFES
used differential decoder

AERR = .97723

9. AGCLB

Common block
used Pin1

AGCLB is the AGC bandwidth in Hz, real default = 1Ø.

10. AGCLG

local variable
set, used, & output Parin

AGCLG = Ø.Ø1

11. AHAT

local variable — pages (4-1 back, 3-14, 3-46 to 3-50, 3-52, 3-96, 3-97)
set DFES
set & used detector
used & output differential decoder
used Bfilt

Detected PSK Digit

AHAT is the complex detected PSK digit developed by the Detector each bit symbol interation after the acquisition decision. In the Detector it is used to compute the error E. The DFES main program sets AHAT= 1+j. It is a calling sequence argument of the subroutine BFILT where it is used to form ALPHA(I), I=1,2,---NCB. AHAT has the values ±1±j.

AHAT is set by DFES to

```
AHAT = (1.Ø, 1.Ø)
```

12. AHAT1

Local variable — pages (3-14, 3-50)
set DFES
set noise filter
set & used differential decoder

AHAT1 is the previous AHAT value

The noise filter sets AHAT1 to

```
AHAT1 = A1
```

DFES sets AHAT1 = (1., 1.)

The differential decoder sets AHAT1 to

```
AHAT1 = AHAT
```

13. AIX

local variable — pages (3-38)
set & used noise filter

AIX is a constant for the 2 pole Butterworth filter

```
AIX = AN*CJ
```

where CJ = CEXP (CMPLX (Ø.,-CX))

14. AKC

local variable
set & used Fwate

Fwate sets AKC to

AKC = 1. / (1. - (6.28 * KFLB / BSR))

15. AL

local variable
set & used Semul

AL = 3.

16. ALGOR

local variable
set & used initialize parameters
used chanel
used forward filter
used detector
pages (3-55, 3-58, 3-92)
used differential decoder
set & used Parin
used Fwate

ALGOR = Algorithy type used in Forward Filter weight adaptation (Integer word for alphanumeric input). ALGOR is either LMS (Least Mean Square), KAL (Kalman algorithm), or FIX (fixed weight input). Default = LMS.

Initialize parameters sets ALGOR = NALG
Parin sets ALGOR = LMS, default

ALGOR	NALG	Weight Adaptation Method
LMS	1	Least Mean Squares algorithm
KAL	2	Kalman algorithm
FIX	3	Weights remain fixed to initialization values
RAKE	4	Rake equalizer

17. ALPHA

a) local variable pages (3-37)
set & used & output noise filter

$$ALPHA = \frac{\pi}{\sqrt{2}} \frac{BRF}{RSR} = \text{normalized filter parameter}$$

b) virtual array Previous chip values
set & used Sync pages (3-82, 3-96, 3-97)

Sync sets ALPHA as

ALPHA (I) = (Ø.,Ø.),

ALPHA(I) = ALPHA (I-NRB)

ALPHA(I) = PN(I)*ADATA

c) array ALPHA (I) = AHAT*ALPHA (I),
I=1,2,...NCB.

set & used Bfilt

ALPHA(I) = ALPHA (I-NCB)

Bfilt sets ALPHA to ALPHA(I) = CONJG(PN(I*NRC)

ALPHA (I) = (Ø.,Ø.)

18. AMAX

local variable
set & used Max

AMAX = -1.Ø

AMAX = CABS (A(J))

19. AN

local variable pages (3-37)
set & used noise filter

AN = 2(1-ALPHA)

20. ARG

local variable
set & used Semul

ARG = FLOAT (I-1)/1ØØ.

ARG = Ø/3 - ALOG1Ø(ARG)

21. ASTEP

local variable
used channel
set Pin1

Pin1 sets ASTEP to
ASTEP = 2. * PI * AGCLG/BSR
and if NA>Ø then ASTEP = 2. * PI/NA

22. B

local variable
set & used Gauran

B = RAN (NRAN1, NRAN2)

23. BC

local variable
set & used channel

$BC = (1-2EC + 2EC^2)\ EDC^2$

24. BDEL

local variable
set & used Pin1

BDEL as set in Pin1

BDEL = RSR / (3. * BRF) + Ø.5

25. BETA

array — pages (3-1 back, 3-17, 3-20, 3-24, 3-29, 3-95 to 3-98)
set DFES
output update input — set & used Bfilt
output differential decoder — set Parin

DFES sets BETA(I) = Ø.Ø,Ø.Ø)

Backward Filter Tap Array

BETA is a complex array dimensioned BETA (40). For NALG=1 or 2 it is updated each bit symbol interation following the acquisition decision by the subroutine BFILT in order to form the backward filter output C. For ALGOR=FIX, the BETA remains fixed at its initial values. Within PARIN the array is indexed as BETA(I), I=1,2...LTAP.

BETA is a calling sequence argument of both PARIN and BFILT.

Bfilt sets BETA to

BETA(I) = CMPLX (RW,QW)

26. BFLB

common block — pages (3-7 back, 3-55, 3-58, 3-95, 3-98)
used Bfilt
set, used & output Parin

Backward Filter Loop Bandwidth in Hz

BFLB is an input parameter to PARIN with a default of 5. It is used by the subroutine BFILT to compute BSTEP.

27. BIX

local variable — pages (3-38)
set & used noise filter

BIX is a constant for the 2 pole Butterworth filter

BIX = BN * CJ

where CJ = CEXP (CMPLX (Ø., -CX))

28. BKC

local variable
set & used Fwate

Fwate sets BKC to

$$BKC = AKC * (1.-1./AKC)$$

29. BN

local variable
set & used noise filter

$$BN = 2\ ALPHA^2$$

30. BRF

common block — pages (5-1 back, 3-36, 3-37, 3-53, 3-58)
used noise filter
used Pinl
set, used, & output Parin

RF Bandwidth in Hz of 2 Pole Butterworth Filter

BRF is a real input constant to PARIN with a default of 3840. It is used by the Noise Filter subprogram to compute the constants ALPHA and FSPACE.

31. BRMS

array — pages (3-1 back, 3-13, 3-17, 3-21, 3-26, 3-27, 3-54, 3-59)
set DFES
used channel
set, used, & output Parin

Channel Tap Gain Doppler Spectrum Standard Deviation

BRMS is a real array, dimensioned BRMS(4) used by the Channel subprogram in updating the Channel Tap Gain array H(I). Indexing is BRMS(I), I=1,2,...CTAP. Its values remain fixed to the initial values input by the subroutine PARIN. The default is BRMS (I)=0, I=1,2,...CTAP.

32. BSR

common block
used initialize parameters
used channel
used noise filter
used differential decoder
used Bfilt
used Fwate
Set, used, & output Parin

pages (3-5 back, 3-12, 3-15, 3-18, 3-24, 3-25, 3-27, 3-29, 3-30, 3-38, 3-47, 3-55, 3-57, 3-58, 3-66, 3-77, 3-87, 3-96, 3-98)

used Noise
used Pinl

Bit Symbol Rate in Hz

BSR is a real input constant to the subroutine Parin with a default of 2400. It is used in Parin to compute

```
NTB = TSR/BSR
NRB = RSR/BSR
NCB = CSR/BSR
```

Initialize parameters uses it to set

```
SIGMA = SQRT (TSR/(BSR * 2. * SNR))
```

The channel uses BSR to compute

```
DC = 2. * PI * DOP(J)/BSR
EC = 2. * PI * BRMS(J)/(BSR * SQ2)
```

The noise filter uses it to set

```
VSTEP = 2 * PI * NFLB * RSR / (BSR * BRF * NRB)
```

The differential decoder computes

```
DRATE = 2. * BSR * (1. - FLOAT (KADAPT) / KRST)
```

Bfilt uses it to set

```
BSTEP = 2. * PI * BFLB / BSR
```

Fwate uses BSR to set

```
AKC = 1. / (1. - (6.28 * KFLB / BSR))
```

Noise uses it to compute

```
SVAR = TSR / (2. * BSR * SNR)
```

Pinl uses BSR to compute

```
DELTA = 2.Ø * PI * FFLB / BSR
ASTEP = 2. * PI * AGCLB / BSR
ESTEP = 2. * PI * MSELB / BSR
KDEL  = 2. * PI * RGLB / BSR
```

33. BSTEP

local variable — pages (3-97, 3-98)
set, used, & output Bfilt

BSTEP = (2π*BFLT)/BSR.

34. C

local variable — pages (4-2 back, 3-45, 3-46, 3-52, 3-96 to 3-98)
set & used detector
output differential decoder
set & used Bfilt

Backward Filter Output

C is the complex backward filter output argument returned by BFILT. It is used by the Detector to form the predecision sample

ZC=Z+C

The detector sets C = (Ø.,Ø.)

Bfilt sets C as

C = (Ø.,Ø.)

C = C + BETA(I) * CONJG (GBACK(JSET(I)))

35. CAS

Noise filter mode indicator

local variable
set DFES — used forward filter
used noise filter — set & output Parin

CAS is set CAS = Ø in DFES and Parin

36. CC

local variable
set & used channel

$$CC = 2EC\sqrt{2EC(1-EC)}EDC$$

37. CIX

local variable pages (3-38)
set & used noise filter

Constant for 2 pole Butterworth filter

CIX = CN * CJ * CJ

where CJ = CEXP (CMPLX (Ø.,-CX)

38. CJ

local variable
set & used noise filter

CJ is set in the noise filter as

CJ = CEXP (CMPLX (Ø.,-CX)),

CJ = (Ø.,Ø.),

and CJ = CJ + PN(K) * XFREQ

39. CLEAR

local variable
set & used Fwate

CLEAR = Ø.

CLEAR = 1.

if CABS (W(I)) > Ø.2 then CLEAR = Ø.

40. CMAG

local variable
set & used noise filter

CMAG is set in the noise filter as

CMAG = CABS (V(I))

41. CN

local variable pages (3-37)
set & used noise filter

CN = 1-2 ALPHA + 2 ALPHA^2

42. CON

local variable — pages (3-89, 3-90)
set & used Fwate

$$CON = \left(\sum_{I=1}^{NTAP} SBAR(i) \quad \sum_{I=NTAP+1}^{NLTAP} \overline{GBACK}\ (JSET\ (I-NTAP))\right) * VKAL(I) * BKC$$

Fwate sets CON to CON = (Ø.,Ø.)

if I ≤ NTAP then

CON = CON + CONJG (SBAR(I)) * VKAL(I) * BKC

IF I > NTAP then

CON = CON + CONJG (GBACK (JSET (I-NTAP))) * VKAL (I) * BKC

43. CSR

common block — pages (3-6 back, 3-12, 3-55, 3-57,
used Taper (Rgen) 3-58, 3-66)
set, used, & output Parin

Chip Symbol Rate in Hz

CSR is a real input constant to the subroutine PARIN. It has a default of 96K and must be an integer multiple of BSR.

44. CTAP

common block — pages (3-17 back, 3-12, 3-15, 3-17,
used initialize parameters 3-21, 3-23, 3-28, 3-54, 3-55,
used channel 3-58, 3-59, 3-60)
set, used, & output Parin

Number of Discrete Channel Paths

CTAP is a fixed integer input to the PARIN subroutine with a default of 1. It has the range $1 \leq CTAP \leq 4$. If the input value of CTAP is greater than 4, PARIN forces CTAP=4. The channel subprogram uses CTAP as the size of the channel arrays H, DELAY, BRMS, POW, DOP, and KSET. The Initialize Parameters subprogram uses it to set the size NQ of the receiver input array Q as

NQ=NTB+INT-NTR+KSET(CTAP)

45. CVAR

local variable
set channel

pages (4-2 back)

Channel Variance

CVAR is the variance used by the Channel subprogram as an argument to the random number generator subroutine GAURAN. It is set to the real value

```
CVAR=POW(J)/2
```

46. CX

local variable
set & used noise filter

CX is set as

```
CX = 2. * PI * II * FSPACE / RSR
```

47. D

local variable
set & used detector
used & output differential decoder
used Taper (Rgen)
set & used Dpgen

pages (4-2 back, 3-49, 3-50, 3-52, 3-67, 3-89)

Transmitted PSK Digit

D is the complex transmitted PSK digit, before encoding, returned to the Detector by DPGEN. It has the values ±1±j. The Detector uses it to set the transmitted PSK symbol A=D. The Differential Decoder uses it in a comparison with DHAT to update the error counter ERROR.

The following process is performed twice to generate the real D(1) and imaginary D(2) parts of the complex output.

(a) The high order bit I is extracted from MWORD.

(b) MWORD is shifted one place to the left by extracting the low order 31 bits and multiplying the result by 2.

(c) If the extracted bit I is a 1, MWORD is replaced by an exclusive OR of MWORD and JWORD.

(d) For I = 1, D(J) = +1

For I = 0, D(J) = -1.

The detector sets D to

D = A if IDEC = Ø

Dpgen sets D to

D(J) = MSIGN

48. DC

local variable
set & used channel

DC is set in the channel as

DC = 2. * PI * DOP(J) / BSR

49. DELAY

array
set, used, & output Parin

pages (3-21 back, 3-13, 3-17, 3-21, 3-23, 3-28, 3-54, 3-59)

Channel Tap Delays in Seconds

DELAY is a real array of size DELAY (4) used by the channel subprogram in updating H(I), I=1,2,--CTAP.

Indexing is DELAY (I), I=1,2,--CTAP. Its values remain fixed to those input by the subroutine PARIN. The default is

$$\text{DELAY (I)} = \frac{\text{I-1}}{2400} ,$$

I = 1, 2, -- CTAP

50. DELTA

local variable
output update input
set Pinl
used Fwate

pages (5-1 back)

LMS Algorithm Step Size

Pinl sets DELTA to

$$\text{DELTA} = 2\pi\frac{\text{FFLB}}{\text{BSR}} .$$

It is the calling sequence argument for the LMS algorithm step size used by FWATE to compute the weight vector W.

51. DERR

local variable
set & used differential decoder

DERR = ERROR

52. DHAT

Detected source digit

local variable pages (3-50)
set detector
set, used, & output differential decoder

The differentially decoded PSK digit is given by

DHAT = AHAT * CONJG(EJ) * CONJG (AHAT1)

The detector defines DHAT as

DHAT = AHAT

53. DOP

array pages (3-21 back, 3-13, 3-17, 3-26,
set DFES 3-54, 3-60)
used channel
set, used, & output Parin

Doppler Shift in Hz

DOP is a real array dimensioned DOP(4) used by the channel subprogram in updating the array H. Indexing is DOP(I), I=1,2,--CTAP. DOP is a fixed real parameter input to PARIN, with a default of

DOP(I)=0, I=1,2,--CTAP.

54. DR

local variable pages (3-99)
set & used differential decoder
used Max

DR is the Dynamic Range Threshold.

The differential decoder sets DR as

DR = ∅

if ERROR ≠ DERR then DR = DERR - ERROR

55. DRATE

local variable pages (3-51, 3-52)
set & output differential decoder

DRATE is the transmitted data rate calculated as

```
DRATE = 2. * BSR * (1.-FLOAT(KADAPT)/KRST)
```

by the differential decoder.

56. E

local variable pages (4-2 back, 3-13, 3-46 to 3-48, 3-58, 3-95)
set DFES
set & used detector
used Bfilt

DFES sets E to

```
E = (Ø.Ø, Ø.Ø).
```

Adaption Error Sample

E is the complex error sample computed each bit symbol iteration by the Detector according to the values of PSK and REF. The Detector also uses E to update the mean square error MSE.

The detector sets E to

```
E = A-ZC
E = AHAT-AC
E = CMPLX(RE,QE)
E = E/2
E = E * EMUL (IERR)
```

57. EBER

local variable pages (3-47, 3-48)
set, used & output detector

EBER = Estimated bit error rate

$EBER = 0.5*ERFC(\rho)$

58. EC

local variable
set & used channel

$EC = 2\pi(BRMS(J)) / \sqrt{2}BSR)$

59. EDC

local variable
set & used channel

EDC = CEXP (CMPLX (Ø.,-DC))

60. EDEL

local variable
set Sync

EDEL is set by Sync to

EDEL = FLOAT (INEXT - IMAX) / RSR

61. EJ

local variable pages (3-14, 3-50, 3-51, 3-66, 3-67)
set initialize parameters
used detector
used differential decoder
set & used Sync
set & used Key
set & used Taper (Rgen)

EJ = (1.,1.)/2 in initialize parameters, Sync, Key, and Taper (Rgen)

EJ = (1+j)/2

62. EMSE

local variable
set & used Fwate

EMSE is set in Fwate to

EMSE = 1. or EMSE - Ø.1

63. EMUL

array
set DFES
set & output Semul

EMUL(1) = 1.Ø Set in DFES

In Semul, EMUL is set to

EMUL(1) = 1.
EMUL(I) = 1.-SUM * EXP(-AL * ARG)

64. ERFC

local variable
set Erfc

Erfc sets ERFC = SUM

The function computes

$$ERFC(X) = \frac{2}{\sqrt{\pi}} \int_{X}^{\infty} e^{-y^2}\, dy, \quad X \geq 0$$

Using the series approximation

$$ERFC(X) \doteq \sum_{I=1}^{5} A(I) * T^{I} * e^{-X^2}$$

65. ERROR

local variable pages (3-13, 3-50, 3-51)
set DFES
set, used & output differential decoder

Error is the total number of errors.

ERROR = Ø. Bit error counter set in DFES

The differential decoder sets ERROR to

ERROR = ERROR + 1 in certain cases

66. ESNR

local variable pages (4-3 back, 3-47, 3-48)
set, used & output detector

Estimated Signal to Noise Ratio

ESNR is the real variable for the estimated SNR computed each bit symbol iteration by the Detector as

$$ESNR = \sqrt{\frac{1-MSE}{2*MSE}}$$

The detector sets ESNR to

ESNR = -9.99E + 32

ESNR = 20. * ALOG1Ø (ESNR)

67. ESTEP

local variable pages (3-15, 3-47)
used detector
set Pin1

The step size for averaging the mean square error is computed

ESTEP = 2π(MSELB)/BSR.

68. F

local variable pages (4-3 back, 3-36, 3-39, 3-47, 3-48)
used noise filter
set & used detector
output differential decoder

Modified Adaptation Error Sample

The Detector computes the complex error F=E/NCB to be used as a calling sequence argument for FWATE and BFILT where it is used in updating W and BETA respectively.

The detector sets F to

F = E

69. FFLB

common block pages (3-8 back, 3-11, 3-55, 3-58)
set, used, & output Parin
used Pin1

Forward Filter Loop Bandwidth in Hz

FFLB is an input parameter to the subroutine PARIN with a default value of 5.

70. FIX
fixed weight input

local variable pages (3-3 back, 3-55)
used Parin
algorithm

no numerical value, determines algorithm

71. FSPACE

local variable — pages (3-37)
set, used, & output noise filter

FSPACE = BRF/2 = Spacing between filter center frequencies

72. GBACK

array — pages (3-22 back, 3-88, 3-89, 3-96
used Fwate — to 3-98)
set Bfilt

Backward Filter Signal Array

GBACK is a complex array dimensioned GBACK(40). It is updated each bit symbol iteration with the latest PSK decision and chip values by the subroutine BFILT which uses it to compute the backward filter output C. The subroutine FWATE uses the updated GBACK in computing the variable CON and array VKAL in the Kalman alogorithm adaptation. GBACK is a calling sequence argument of the subroutines BFILT and FWATE. It is indexed as GBACK(JSET(I)). I=1,2,--LTAP.

Bfilt sets GBACK to

GBACK (JSET(I)) = (Ø.,Ø.),

GBACK(JSET(I)) = GBACK (JSET(I)) + CONJG(PN(J*NRC))
* CONJG(ALPHA(J + JSET(I)-1))/NCB

73. GCON

common block
set DFES
output update input
set & used channel
used interpolator
output detector
set, used, & output Sync
set & used Parin

pages (3-8 back, 3-11, 3-17, 3-19, 3-29, 3-33, 3-56, 3-58)

Gain Control Constant

When the bit synchronization subroutine SYNC is required for acquisition (NA > 0 and SMODE = 0), GCON is computed recursively for IBS = NA interations. The initial value of GCON is 1 set in DFES. If NA = 0, which forces SMODE = 1, GCON is an input parameter to the subroutine PARIN. Whenever SMODE = 1, the value of GCON remains fixed.

The channel sets GCON to
GCON = (1.-ASTEP)*GCON+ASTEP/SQRT(SPOW)

Sync sets
GCON = GCON/SQRT(SUM*2.)

Parin sets
GCON = 1 if GCON = Ø

74. H

array
set DFES
set, used, & output channel
set, used, & output Parin

pages (3-22 back, 3-12, 3-21, 3-26, 3-27)

Channel Tap Gain

H is a complex array dimensioned H(4) for the channel subprogram and redefined as a real array H(8) in the parameter input subroutine PARIN. Initial values are input by PARIN with the default H(1)=1, all other H(I)=0. Indexing is H(I), I-1,2,---CTAP. The array H is updated each bit symbol interation for ICHAN≠0.

75. HD

Previous channel value

array pages (3-27)
set DFES
set & used channel
set Parin

The channel subprogram sets HD as

HD(J) = YC

and the initial values of the channel are stored, i.e.,

HD(I) = H(I), I=1,2,...NCTAP2

as set in Parin DFES initially sets HD to

HD(I) = (Ø.Ø, Ø,Ø)
and HD(1) = (1.Ø, Ø.Ø)

76. HP

Preset channel value

array
set DFES
set & used channel
set Parin

Parin sets HP to

HP(I) = H(I) where I = 1,NCTAP2

DFES initially sets HP to The channel sets

HP(I) = (Ø.Ø,Ø.Ø) HP(J) = H(J)

HP(1) = (1.Ø, Ø.Ø)

77. I

local variable pages (3-38)
used DFES
set & used initialize parameters
set & used differential decoder
set & used update input
set & used interpolator
set & used noise filter
set, used, & output forward filter
set, used, & output compressor
set & used Taper (Read)
set & used Noise
set & used Erfc
set & used Parin
set & used Fwate
set & used Sync
set & used Bfilt
set & used Max
set, used, & output Semul
set & used Dpgen
set & used Pinl

example

I = 1,2,...MTAP.

78. IBDEL

local variable
used & output update input
used forward filter
used Fwate
set Pinl

IBDEL is set in Pinl to

IBDEL = BDEL

79. IBETA

algorithm
local variable pages (3-56, 3-59)
set & used Parin

IBETA = Initial BEAT (I) value flag (Integer).

IBETA =0, BETA (I) = default values.

IBETA=1, BETA (I) from hand input.

80. IBLOCK

local variable
set, used, & output Taper (Read)

Taper (Read) sets IBLOCK to

IBLOCK = Ø and IBLOCK = IBLOCK + 1

81. IBRMS

local variable
set & used channel

Channel sets IBRMS to

IBRMS = Ø and IBRMS = 1

82. ICH

array pages (4-3 back, 3-16, 3-65)
set Pin1
used Taper (Rgen)

Tape Simulator Chip Shift Register

ICH is the integer shift register for the signal tape simulator subroutine TAPER (file name RGEN). It is set to its starter value by the Initialize Parameters subprogram

ICH = ICHIP

TAPER-RGEN uses it in the call to DPGEN to generate the chip values.

Pin1 sets ICH to

ICH(I) = ICHIP(I)
ICH(I+16) = ICHIP (I+16)

83. ICHAN

local variable pages (3-14, 3-16)
set DFES
used channel
used Parin

If ICHAN = 1 indicating a non ideal channel situation.

If the default condition for the CHANNEL subprogram (3.4.3) is detected ICHAN = 0.

84. ICHIP

array
set, used & output Pin1
used Key

Receiver Chip Shift Register

ICHIP is the integer shift register for the receiver chip data generation of the PN sequence.

Pin1 sets ICHIP to

ICHIP(I) = MOD(IL,2)

ICHIP(I+16) = MOD(IH,2)

85. ICHP

local variable
used Taper (Rgen)

86. IDATA

array
used & output Taper (Read)

87. IDEC

common block
used detector
used differential decoder
used Sync
used Taper (Rgen)
set Parin

pages (3-20 back, 3-14, 3-15, 3-50, 3-66, 3-67)

Differential Decoder Indicator

Parin sets IDEC = 1 for REF=0, and IDEC=0 (no decoding required) for REF $\geq$ 1. When IDEC=1, the error rate is recalculated as

RATE=RATE/2

If IDEC=1, the Differential Decoder must decode to obtain DHAT and the SYNC subroutine must encode the bit symbol returned by DPGEN.

88. IDEL1

local variable pages (3-16)
set DFES
Tape Simulator Previous PSK Symbol

DFES sets IDEL1 to

IDEL1 = (1.Ø,1.Ø)

89. IDOP

local variable
set & used channel

IDOP is set in channel as

IDOP = Ø and IDOP = 1

90. IEOF

local variable pages (3-63, 3-64)
set & used Taper (Read)

IEOF = 0 End of file indicator returned by TREAD.

Taper (Read) sets IEOF = Ø

91. IEOT

local variable
set DFES
used channel
set Noise

IEOT is set

IEOT = Ø in DFES and NOISE

= 1 for end of NOISE(Tape)

92. IERR

local variable
set DFES
used detector
set & used differential decoder
set, used, & output Taper (Read)

IERR = 1 in DFES

IERR = Ø in Taper (Read)

IERR = XERR + 1 in differential detector
and if IERR > 5Ø, IERR = 5Ø

93. IFIX

local variable
used Parin
integer 'FIX'

no numerical value, determines algorithm

94. IH

local variable
set & used Pin1

IH = 24329 in Pin1
and
IH = IH/2

95. II

LOCAL VARIABLE
SET & used noise filter

IT is set in the noise filter as

IT = I-NV

96. IK

local variable
set & used Fwate

IK is set in Fwate as

IK = ISET(I) + K + IBDEL

97. IL

local variable
set & used Pinl

IL is set in Pinl to

IL = 1432

and

IL = IL/2

98. IMAX

local variable
set, used, & output Sync

IMAX is set to IMAX = 1

and

IMAX = MSYNC(1) in Sync

99. IMIN

local variable
set & used Sync

IMIN is set in Sync to

IMIN = 9999

100. INC

local variable
set & used Sync

Sync sets INC to

INC = Ø,

INC = INC + 1,

and

INC = LM

101. INCH

local variable pages (3-56, 3-59)
set & used Parin

INCH = Input Channel Flag (Integer).
0 = Channel default parameter values used.
1-Channel parameter values from hand input.

102. INEXT

local variable pages (3-85)
set, used, & output Sync

INEXT is set by Sync to

INEXT = 1

and

INEXT = MSYNC(2)

103. INT

common block pages (3-3 back, 3-12, 3-14, 3-15
used initialize parameters 3-29, 3-54, 3-57, 3-79)
used update input
set, used, & output Parin

Number of Interpolator Samples

INT is an input parameter to the subroutine PARIN. It is an odd integer of range $1 \leq INT \leq 11$ with a default of 5. The Initialize Parameter subprogram uses it to set the Interpolator half span interval INT1, the length NQ of the input array Q and the length NR of the receiver sample array R as follows:

INT1 = (INT - 1)/2

NQ = NTB + INT - NTR + KSET (CTAP)

NR = NTB + INT - NTR

In the bit symbol iteration processing it is used to set the number of additional input samples NRQ to be provided by the subroutine TAPER for IBS = 1 to NRQ = INT-NTR

The Initialize Parameters subprogram will reset INT for $INT \leq NTR$ to NTR+1 for NTR even or NTR+2 for NTR odd. From that point on the value of INT remains fixed.

Parin sets INT to

INT = ((NTR+1)/2) * 2 +1

104. INT1

common block pages (3-13, 3-19, 3-33)
set initialize parameters
used update input
used interpolator

INT1 = (INT-1)/2 Interpolator half span

105. INV

local variable pages (3-56, 3-59)
set & used Parin

INV = Input V(I) value flag (Integer).
INV = 0, V(I) = default values.
INV = 1, V(I) from hand input.

*Line 22: INV

0 = default V(I) values
1 = hand input of V(I) values

This line is input only for MTAP > 1

106. IP

local variable
set & used Taper (Rgen)

IP is set

IP = ICHP * EJ by Taper(Rgen)

107. IPLUS

local variable
set & used Sync

Sync sets IPLUS = Ø and IPLUS = 1

108. IPOS

local variable
set & used Taper (Read)

IPOS is set to IPOS = Ø and IPOS = 3 by Taper(Read)

109. IPRIN

local variable pages (3-14, 3-22, 3-27, 3-40)
set update input
used channel
used interpolator
used compressor
used noise filter

IPRIN = Print parameter from UPDATE INPUT (3.4.2). (Integer).
IPRIN = 0 Output print flag

110. IQ

local variable
set & used interpolator

The interpolator sets IQ as

IQ = I + INT1 + 1

111. IQSET

local variable
set initialize parameters
set & used update input
set noise filter

IQSET is set IQSET = Ø by Update Input.

The flag IQSET is set to IQSET = 1 in the initialize parameters.

IQSET=SMODE as set in the noise filter.

112. IRAKE

algorithm

local variable
used Parin

IRAKE indicates the 'RAKE' algorithm--RAKE equalizer

113. ISET

array
used initialize parameters
used & output update input
used & output forward filter
used Fwate
set, used, & output Sync
set & used Parin

pages (3-23 back, 3-13, 3-16, 3-18 3-20, 3-41 to 3-43, 3-53, 3-81, 3-83 to 3-85, 3-87, 3-89)

Transversal Filter Delay

ISET is an integer array of non-negative values dimensioned ISET(100). It may be input by PARIN or computed by the subroutine SYNC, after which its values remain fixed. ISET(1) defines the main tap of the forward filter and is used by the Initialize Parameters subprogram to compute the parameter

NSHIFT = NTR*ISET(1)

Indexing is ISET(I), I=1,2,---NTAP. In the Forward Filter subprogram ISET(I) is used in the index value of X for computing the forward filter output Y. The subroutine FWATE also uses ISET(I) in index value of X for updating the array SBAR. ISET is a calling sequence argument of the subroutines SYNC, FWATE, and PARIN.

ISET(1) defines main tap of forward filter.

114. ISMAX

local variable
set & used update input

pages (3-18, 3-42)

The span of the forward filter is computed as

$$ISMAX = \underset{I}{MAX}\ ISET(I)$$

Update input sets ISMAX to

ISMAX = Ø

ISMAX = ISET(I) if ISET (I) > ISMAX

115. ISNR

local variable
set DFES
used Parin

ISNR is set in DFES to the values SNR is to be set at.

116. IT

local variable
set initialize parameters
used Semul

Initialize Parameters sets IT as

IT = KFLB

117. ITRY

local variable
set & used Taper (Read)
set & used Parin

ITRY is set by Taper (Read) as

ITRY = Ø and ITRY = ITRY + 1

Parin sets ITRY to

ITRY = Ø and ITRY = 1

118. IW

local variable
set & used Parin

IW = Initial Weight Value flag (Integer)
IW = 0, W(I) = default values.
IW = 1, W(I) initial values from hand input

119. IX

local variable pages (3-18, 3-36, 3-37)
set and output initialize parameters
used noise filter

The number of bit symbol iterations to be executed with no signal present is computed.

If NOSIG = 0 (Signal Present), IX = 0

If NOSIG = 1 (Signal Absent), $IX = \frac{3(BSR)}{2\pi(NFLB)}$

The simulation automatically cycles through

IX = [3*RSR/(2π*NFLB*NRB)]

$x \leq [x] < x + 1$, [x] integer

The NOISE Filter also has the number of adaptation cycles input from UPDATE INPUT (3.4.2);

IX = 3*RSR/(2.*PI*NFLB*NRB)

120. IXF

local variable
set nose filter

The noise filter sets IXF as

IXF = 1

IXF = (NRB + K-1) * NRB + I IFX = J + 1

IXF = (K-1) * NRB + 1 IFX = J

121. J

local variable
set & used update input
set & used channel
set & used noise filter
set, used, & output forward filter
set & used Taper (Read)
set & used Sync
set & used Fwate
set & used Bfilt
set & used Max
set & used Semul
set & used Dpgen
set & used Parn

example: J = 1, CTAP

122. JBLOCK

local variable
set, used, & output Taper (Read)

JBLOCK is set by Taper (Read) as

JBLOCK = Ø and JBLOCK = JBLOCK + 1

123. JBS

local variable
set & used channel

Channel sets JBS to

JBS = RJBS

124. JFACT

local variable
set & used Semul

JFACT is set by Semul as

JFACT = 1 and JFACT = JAFACT * (J)

125. JH

local variable
set & used Pin1

Pin 1 sets JH as

JH = "7702 and JH = JH/2

126. JL

local variable
set & used Pin1

Pin 1 sets JL as

JL = "27607 and JL = JL/2

127. JMAX

local variable
set & used Bfilt

Bfilt sets JMAX as

JMAX = Ø

JMAX = JSET(I)

JMAX = JMAX + NCB-1

JMAX = (JMAX/NCB) * NCB + NCB

128. JP

local variable
set & used Semul

JP is set by Semul as

JP = 1, M+1

129. JRAN1

Integer starter for Gauran used by noise

local variable
set DFES

DFES sets JRAN1 = Ø

130. JRAN2

Integer starter for Gauran used by noise

local variable
set DFES

DFES sets JRAN2 = Ø

131. JSET

array
set DFES
set, used, & output Sync
used Fwate
used & output Bfilt
set Parin

pages (3-23 back, 3-53, 3-59, 3-81, 3-85, 3-88, 3-89, 3-95, 3-97)

Backward Filter Delay

JSET Is an integer array of non-negative values dimensioned JSET(120). It may be input by PARIN or computed by SYNC. Indexing is JSET(I), I=1,2,---LTAP. JSET is a calling sequence argument to the subroutines SYNC, BFILT, FWATE, and PARIN. FWATE uses JSET as an index for the array GBACK and BFILT uses it in the index for the GBACK and ALPHA arrays.

132. JTIME

local variable
set DFES
used differential decoder
used Parin
used update input

JTIME is set in DFES to values desired; such as, JTIME = 1,3

133. JWORD

a) array pages (3-69)
used Dpgen
set & output Pin1

Pin1 sts JWORD as

JWORD(I) MOD(JL,2)
JWORD(I+16) = MOD(JH,2)

b) common block pages (3-14 back)
set & output Pin1
used Dpgen

Polynomial for the Receiver Message and Chip Random Number Generator

JWORD=I*(2**16)+J Pin1 sets JWORD to

where JWORD(I) = MOD(JL,2)

$I = 7702_8$ JWORD(I+16) = MOD(JH,2)

$J = 27607_8$

JWORD has the actual representation of 1760427607

The message and chip random number generator DPGEN uses JWORD in an exclusive OR with the message in chip shift register MWORD to produce a new shift register value when the last shift resulted in a carry of "1."

The integer JWORD is the COMMON block 32 bit polynomial used for both message and chip data generations.

JWORD = 1760427607 (base 8)

134. K

local variable pages (3-38, 3-40, 3-41, 3-43, 3-64)
set & used channel
set & used interpolator
set, used, & output noise filter set & used Sync
set, used, & output forward filter set & used Fwate
set & used Taper (Read) set & used Dpgen

examples K = NRB, NRB-1, ... 2,1

the last K unused data samples (K=HIGH-NVIN)

135. KADAPT

common block
used forward filter
used detector
used differential decoder
used Pin1
set, used, & output Parin

pages (3-20 back, 3-11, 3-15, 3-49, 3-56)

Number of Adaptation Cycles for Kalman Algorithm

KADAPT is a fixed integer parameter input to PARIN when ALGOR=KAL. It has a default of 1000. KADAPT is used to compute RATE and DRATE.

Parin uses it to set KEND=KADAPT+KVAR.

136. KAL

algorithm

pages (3-55)

local variable
used Parin

KAL (Kalman algorithm)

No numerical value, determines algorithm.

137. KALA

local variable
set DFES
set & used initialize parameters
used channel

pages (3-16)

DFES sets KALA = Ø

Initialize parameters sets KALA = 2 * NTAP
if NALG = 2 and SMODE = 1

This is accomplished with the flag KALA which is used to fix the weights (NALG=3) for this period of time.

138. KEND

common block pages (3-19 back, 3-15, 3-91)
used Fwate
set & used Parin

Kalman Adaptation Cycle Limit

Subroutine PARIN sets the integer constant

KEND=KADAPT+KVAR

It is used by FWATE in a decision making comparision with KNUM.

139. KFLB

Kalman filter loop bandwidth. Default = Ø

common block
set DFES
used initialize parameters
used update input
used detector
used Fwate
set & output Parin

DFES sets KFLB = Ø.Ø

Parin also sets KFLB = Ø

140. KKN

common block
sets DFES
set & used Fwate

KKN is set by DFES as

KKN = 1

KKN is set by Fwate as

KKN = 2

141. KLMS

common block — pages (3-19 back, 3-88, 3-96, 3-98)
set detector
used Bfilt
set, used, & output Fwate

Kalman/LMS Adaptation Indicator

KLMS is an integer variable with a value of 0 or 1. Initially when NUM=1, FWATE sets KLMS=1 for NALG=1 and KLMS=0 for NALG=2. When KLMS=1, FWATE updates the weight vector W using the least mean squares algorithm. For KLMS=0, the Kalman algorithm is used. For NALG=2 FWATE leaves KLMS=0 until KNUM > KEND or KNUM=KRST when it sets KLMS=1. For each KVAR < KNUM $\leq$ KEND, KLMS=0.

In the subroutine BFILT the method used to compute the array BETA depends on the value of KLMS.

142. KNUM

common block — pages (3-18, 3-19 back, 3-14, 3-90, 3-91)
set DFES
set, used, & output Fwate

Kalman Adaptation Bit Symbol Iteration Counter

The integer variable KNUM is set to 0 by the DFES main program. When NALG=2, the subroutine FWATE increments KNUM by 1 each bit symbol iteration until KNUM=KRST. At this point, it is reset

```
KNUM=0
```

FWATE sets

```
REF=3 for KNUM=KVAR

REF=0 for KNUM=KEND

KLMS=0 for KNUM ≤ KEND
       or  KNUM ≥ KRST

KLMS=0 for KNUM > KVAR
```

KNUM is used computing the FWATE variables

```
AKC=FLOAT(KNUM+1)/KNUM

BKC=1./KNUM
```

143. KRST

common block — pages (3-19, 3-20 back, 3-49, 3-56, 3-58, 3-88, 3-91)
used detector
used differential decoder
used Pinl
set, used, & output Parin
used Fwate

Number of Cycles for Kalman Algorithm to Restart

KRST is a fixed integer input to PARIN when ALGOR=KAL. It has a default value of 100. KRST is used in computing the error rate RATE and actual data rate DRATE when NALG=2. FWATE uses KRST in a comparison with KNUM in order to set KLMS.

144. KSET

array — pages (3-11, 3-15, 3-17, 3-23, 3-24)
set DFES
used initialize parameters
used channel
set & output Parin

DFES sets KSET to

$$KSET(I)=\emptyset$$

If ICHAN≠0, the channel transversal filter delays are computed as

$$KSET(I) = TSR*DELAY(I)+0.5 \qquad I-1,2,...CTAP$$

KSET(I) = Transversal filter delay of Ith channel tap expressed in units of 1/TSR. (Integer)

$$KSET(I)\geq 0=1,2,...CTAP.$$

If a nontrivial channel is selected ICHAN=1 and the subprogram computes the set of integers corresponding to the number of tape sampling intervals for each path delay, i.e.,

$$KSET(I) = TSR*DELAY(I) + 0.5. = XKSET$$

as in Parin

145. KSTEP

local variable — pages (4-4 back, 3-89 to 3-92, 3-96, 3-98)
set & used Fwate
used Bfilt

Kalman Step Variable

KSTEP is a real variable computed by FWATE for use in its Kalman algorithm adaptation of the weight vector W and in the Kalman algorithm update of the BETA array in BFILT. KSTEP is a calling sequence argument of FWATE and BFILT.

Fwate sets KSTEP to

```
KSTEP = BKC/(EMSE + REAL(CON))
```

146. KSYNC

local variable — pages (3-18)
set initialize parameters
used update input
set noise filter

Synchronization flag is

```
KSYNC = 1.
```

147. KVAR

common block — pages (3-20 back, 3-11, 3-15, 3-56, 3-58, 3-88, 3-90, 3-91)
set, used, & output Parin
used Fwate

Number of Iterations for Adaptation of Kalman Inverse

KVAR is a fixed integer parameter input to PARIN.

Parin sets KVAR = Ø

PARIN uses it to set

```
KEND=KADAPT+KVAR
```

The subroutine FWATE uses it to set

```
REF=3 for KNUM=KVAR
```

and

```
KLMS=0 for KNUM > KVAR
```

148. LIMIT

local variable pages (3-82)
set & used Sync

LIMIT = NPN + NRB-1

149. LM

local variable
set & used Sync

Sync sets LM=Ø and in special cases to LM=LM+1

150. LMS
algorithm

local variable pages (3-55)
used Parin
no numerical value
determines algorithm

LMS (Least Mean Square)

Default = LMS

151. LOUT

common block
set DFES

LOUT is set in DFES as LOUT = 5

152. LP

local variable
set & used Sync

Sync sets LP = Ø and in certain cases to LP = LP+1

153. LPD

local variable pages (3-66, 3-67)
set & used Taper(Rgen)

LPD = 0, Chip counter.

154. LRC

local variable pages (3-94)
set & used key

KEY sets LRC

LRC = LRC + 1

if LRC = NRC then LRC = Ø

LRC = 1,2,...NRC

155. LRP

local variable pages (3-66, 3-67)
set & used Taper (Rgen)

LRP = 0, Tape samples per chip symbol counter.

156. LTAP

common block pages (3-12 back, 3-17, 3-19, 3-52
used detector to 3-55, 3-59, 3-87, 3-88,
used differential decoder 3-90, 3-95 to 3-98)
set, used, & output Sync
used Bfilt
set, used, & output Parin
used Fwate

Number of Backward Filter Taps

LTAP is a fixed integer parameter input to the subroutine PARIN. It indicates the presence (LTAP≥1) or absence (LTAP = 0) of backward filter taps.

In the backward filter subroutine, BFILT, LTAP is sthe size of the arrays JSET and BETA and is used to define the number of chip values stored in the array ALPHA as LTAP*NCB.

The forward filter subroutine, FWATE, uses LTAP to define the size of the Kalman algorithm arrays PVAR and KVAL as

NLTAP=NTAP+LTAP

157. LTAP1

local variable pages (3-85)
set & used Sync

LTAP1 = LTAP/2.

158. LTAPE

local variable pages (6-1 back, 3-35)
used channel
used detector
set & used Taper(Read)
set Taper(Rgen)
used Sync

End of Input Tape

LTAPE is the integer flag for the end of file reached on the input tape. It is initially set to 0 by TAPER-READ and set to 2 when an end of file is read on the input tape. If TAPER returns LTAPE=2 bit iteration processing ends.

TAPER(RGEN) sets LTAPE = Ø

159. M

local variable pages (3-99, 3-100)
set Max
set & used Semul

M = Dimension of MSET (integer, $M \leq N$) where $1 \leq M \leq N$. The final value of M depends on when the ratio of the next largest magnitude to the largest drops below the dynamic range threshold.

160. MA

array pages (3-99)
set & used Max

The integer array MA(I), I=1,2,...N, is the Max-A-Index Stored indicator array; MA is used as follows in processing:

MA(I)=0, A(I) index I not stored in MSET

MA(I)=1, A(I) index I stored in MSET.

Initially, MA(I)=0 for all I.

161. MES

Transmitter Shift Register

array
set Pin1

MES is set by Pin1 as

MES(I) = MESS(I)

MES(I+16) = MESS(I+16)

162. MESS

array
set, used, & output Pin1

MESS is set in Pin1 to

MESS(I) = MOD(ML,2)

MESS(I+16) = MOD (MH,2)

163. MH

local variable
set & used Pin1

MH is set by Pin1 as

MH = 27945

MH = MH12

164. MI

local variable pages (3-85)
set & used Sync

Sync sets MI (delay) to

MI = |INEXT-IMAX|/NRC chip values and

MI = IMAX-(MSYNC(I)-IMAX)

165. MODE

local variable pages (3-56, 3-57)
used Parin

MODE = Input mode indicator (Integer).

Mode = 0, Interactive mode
Mode = 1, Batch mode.

166. MR

local variable
used Sync

167. MSE

local variable pages (3-48, 3-90, 3-91, 3-96)
set DFES
set, used, & output detector
set & used Fwate
used Bfilt

Mean Square Error

DFES sets MSE = Ø.Ø

MSE is the mean square area real value computed each bit symbol iteration for SMODE=1 by the Detector as

MSE = 1 if MSE > 1

MSE = (1. - ESTEP) * MSE + ESTEP * TEMPF * TEMPF

Each iteration that the counter NUM is an integer multiple of ISKIP it is used by the Detector to compute ESNR. It is included as a calling sequence argument to the subroutine BFILT where it is used in the decision skip the update of the ALPHA and BETA arrays if NALG=2, KLMS=1, and MSE>0.10.

168. MSELB

common block pages (5-2 back, 3-12, 3-15, 3-54, 3-58)
used Pinl
set, used, & output Parin

Mean Square Error Loop Bandwidth in Hz

MSELB is a real input parameter to PARIN with a default of 1.

Parin sets MSELB = 1 if MSELB = Ø

169. MSET

output integer array

array pages (3-99, 3-100)
set & used Max

MSET(I) = Index pointer array to A in decreasing magnitude order,

I-1,2,...M (Integer)

A(MSET(1)) = largest |A|

A(MSET(2)) = 2nd largest |A|

.
.
.

A(MSET(M)) = Mth largest |A|

integer array MSET(I), I=1,2,...M

Max sets MSET to

MSET(I) = J

where

J = 1,N

170. MSIGN

local variable
set & used Dpgen

Dpgen sets MSIGN as

MSIGN MWORD(32)

171. MSYNC

array pages (3-24 back)
used & output Sync

Synchronization Index Array

MSYNC is an integer array of maximum dimension MSYNC(180). It is returned to the subroutine SYNC by MAX containing the index values to the synchronization array RSYNC in order of the decreasing magnitude values of RSYNC. SYNC uses MSYNC(1) and MSYNC(2) to set IMAX and INEXT for the computation of TI and NNI.

172. MTAP

common block
used update input
used noise filter
used Pin1
set, used, & output Parin

pages (3-12, 3-13 back, 3-12, 3-15, 3-17, 3-36 to 3-40, 3-55, 3-58, 3-59)

Number of Noise Filter Taps

MTAP is an input parameter to the PARIN subroutine with a default of 1. MTAP must be an integer in the range $1 \leq MTAP \leq 25$. If the MTAP input is even PARIN forces it to be odd by setting

MTAP=MTAP+1

The value of MTAP then remains fixed. PARIN also sets NFLB=0 for MTAP=1.

Subroutine Pin1 uses it to set the constant NV used in the Noise Filter subprogram as

NV=(MTAP+1)/2

MTAP defines the size of the noise filter arrays V(I) and XFREQ(K,I), I=1,2,...MTAP. When MTAP=1 the Noise Filter subprogram is bypassed.

173. MULT

local variable
set & used channel

MULT is set in channel to

MULT = (JBS-1)/NTB

174. MWORD

array pages (3-69, 3-70)
set & used Dpgen

Message/Clip Shift Register

MWORD is the shift register input to the random number generator for the message and chip data subroutine DPGEN.

Dpgen sets MWORD

MWORD(K) = MWORD(K-1)

MWORD(1) = Ø

MWORD(K) = MWORD(K) + JWORD(K)

if MWORD(K) = 2 then MWORD(K) = Ø

175. N

a) local variable pages (3-99)
used Max
set & used key
set Taper(Read)

N = Dimension of A (positive integer)

b) array pages (3-24 back, 3-22, 3-23, 3-25, 3-26, 3-79, 3-80)
used channel
set & used Noise

Discrete Noise Sequence

N is the complex noise sequence array returned by the subroutine NOISE dimensioned N(90). Indexing is N(I), I-1,2,---NR. It is used in the Channel subprogram in forming the receiver sample array R.

Noise sets N to

N(I) = N(I-NTB)

N(I) = NDATA(NOP)*SF

N(I) = SUM1* CMPLX(S(1),S(2))

176. NA

local variable
used initialize parameters
set, used & output Sync
used Pin1
set Parin

pages (4-5 back, 3-12, 3-14, 3-24, 3-53, 3-58, 3-81, 3-82)

Number of Bits Averaged before Acquisition Decision

NA is the integer input parameter to initialize parameters for the number of bit symbol iterations used by SYNC to reach an acquisition decision. For NA=0 the Initialize Parameters subprogram sets SMODE=1, indicating that SYNC is not to be used. When NA>0, SYNC decrements NA by 1 each time it is called until NA=0 when SYNC computes NNI, TI, GCON, and sets SMODE=1. Whenever SMODE=1 NA remains an unused constant.

Parin sets NA

NA = Ø

if JTIME = 1 then NA = 2Ø or some chosen number

NA = Number of bit symbols to be averaged in the correlation (Integer).

177. NALG

common block — pages (3-2 back, 3-12, 3-16, 3-58, 3-87, 3-88)
set & used initialize parameters
used update input
set channel
set & used detector
used differential decoder
used Fwate
set & used Parin

Algorithm Indicator (NALG)

NALG is the integer indicator for the adaptation algorithm used by FWATE in updating the forward filter weight vector w. The subroutine PARIN sets NALG to the following values according to the input value of ALGOR:

ALGOR	NALG	Weight Adaptation Method
LMS	1	Least Mean Squares algorithm
KAL	2	Kalman algorithm
FIX	3	Weights remain fixed to initialization values
RAKE	4	Rake equaliizer

NALG remains constant unless the Kalman algorithm is specified (NALG = 2) and the synchronization subroutine is not used (SMODE = 1). When this occurs, the Initialize Parameters subprogram temporarily sets NALG = 3 to force a delay in the adaptation. When 2*NTAP iterations have been completed, NALG is reset to its original input value of 2.

The Detector sets AHAT = A when NALG = 2 and REF = 3. The Detector also calls the BFILT subroutine to update BETA for NALG = 1 or 2 and LTAP $\geq$ 1.

Initialize parameters sets NALG = 3 if KALA > Ø.

The channel sets NALG = ALGOR if KALA > Ø and RNUM > KALA.

The detector sets NALG = ALGOR.

178. NBLOCK

local variable
set Taper(Read)

NBLOCK is set by Taper(Read) as NBLOCK = 5ØØØ

179. NBYTE

local variable
set Taper (Read)

pages (3-63)

NBYTE = 3840 Number of bytes per block on the signal input tape.

180. NCB

common block
output update input
used Taper (Rgen)
used Bfilt
set Parin

pages (3-16 back, 3-13, 3-19, 3-96, 3-97)

Number of Chip Symbols per Bit Symbol

NCB is a fixed integer defined by Parin as

NCB = CSR/BSR

The BFILT subroutine uses NCB to the ALPHA array size to LTAP*NCB, where NCB is the number of new ALPHA values computed for each bit symbol iteration.

181. NCTAP2

local variable
set & used Parin

Parin sets NCTAP2 to

NCTAP2 = 2*CTAP

182. NFLB

common block
used initialize parameters
set & used noise filter
used detector
set, used, & output Parin

pages (3-7 back, 3-12, 3-18, 3-36, 3-37, 3-39, 3-40, 3-55, 3-58)

Noise Filter Loop Bandwidth in Hz

NFLB is a real input parameter to the subroutine PARIN. The Initialize Parameters subprogram uses it in computing the number of iterations for NOISE FILTER adaptation IX and the Noise Filter subprogram uses it in computing VSTEP.

When NFLB=0, the noise filter weights, V(I), I=1,2,--MTAP, are fixed. If NFLB>0, NFLB is reset to 0 when IBS reaches IX. The subroutine PARIN sets NFLB=0 when MTAP=1.

183. NGEN

local variable
set & used update input
used Taper (Read)
used Taper (Rgen)

pages (4-6 back, 3-62, 3-63, 3-65, 3-66)

Number of Input Samples Accessed by TAPER

NGEN is the integer number of new input samples for TAPER-RGEN to generate or the number of tape samples for TAPER-READ to generate. It is a calling sequence argument for both versions of TAPER. NGEN=NTB+NRQ for each bit symbol iteration unless it is the first iteration where SMODE=1. (KSYNC=1 and SMODE=1). Then it is increased by NSHIFT.

184. NI

local variable
set & used Sync

NI = I-1 as set by Sync

185. NIN

Noise input indicator

local variable
set DFES
set & used initialize parameters
used differential decoder
used Noise
set & used Parin

NIN = Ø as set by DFES, Initialize Parameters, and Parin

Parin also sets NIN = 1

186. NLTAP

local variable
set & used Fwate

pages (3-90, 3-91)

is NLTAP = NTAP + LTAP where NTAP is the number of forward filter taps and LTAP is the number of backward filter taps.

187. NN

local variable
set & used Noise

NN is set by Noise to

NN = NTB

NN = NR if RIBS = 1

188. NNI

common block
set DFES
output update input
set channel
used Taper (Rgen)
set & output Sync
set Parin

pages (3-9 back, 3-11, 3-17, 3-19, 3-56, 3-58, 3-63, 65, 3-66, 3-83, 3-85)

Number of Input Samples to Be Skipped in Order to Produce Bit Synchronization

When the SYNC subroutine is required for acquisition (NA > 0 and SMODE = 0), NNI is determined by SYNC. The initial value of NNI is 0. If SYNC is not required (NA = 0), NNI is an input parameter to PARIN. The value of NNI set by SYNC or input by PARIN is used for only one bit symbol iteration call (NUM = 1) to the Tape Read subroutine TAPER (Rgen). After each call to TAPER, NNI is reset to 0.

TAPER (Rgen) uses NNI in computing the number of input samples to read as

NK = NGEN + NNI

NNI is set to NNI = Ø by Sync, DFES, and channel Sync sets

NNI = IMAX-1

189. NOSIG

common block pages (3-18 back, 3-17, 3-22, 3-26,
used and output initialize parameters 3-55, 3-57)
used channel
set & used noise filter
used differential decoder
Set & output Parin

Input Signal Control Indicator

NOSIG is an input integer parameter of 0 or 1 to PARIN. NOSIG=0 is the normal operation mode. When NOSIG = 1, there is no signal input, R(K) = N(K). If NFLB = 0, PARIN sets NOSIG = 0.

The NOSIG-1 option is no longer used in the program.

190. NOZDC

common block pages (3-21 back, 3-22, 3-26,
used channel 3-55, 3-57)
set & output Parin

DC Noise Indicator

NOZDC is a fixed integer parameter input to PARIN. NOZDC=0 is the normal default case. *NOZDC=1 implies a test case of DC NOISE.*

191. NPD

local variable pages (3-66)
set & used Taper (Rgen)

NPD = CSR/BSR, Number of chip symbols per bit symbol

NPD = NCB

192. NPN

local variable pages (3-81, 3-82)
set, used, & output Sync

NPN = RANGE*6000*RSR*1.E-9 = QN

NPN = NPN+1 IF QN > NPN

The program exits if NPN is greater than 180

193. NPOW

local variable
set & used channel
used & output detector

NPOW = JBS - MULT * NTB

194. NQ

local variable pages (3-15)
set initialize parameters
output update input
used channel

NQ = NTB+INT-NTR+KSET(CTAP)

195. NR

common block pages (3-9 back, 3-13, 3-19, 3-63, 3-80)
output update input
used Taper (Both)
used Noise
set, used, & output Parin
used channel

Number of Receiver Input Samples - Integer

NR is the size of the Receiver input array R.

Parin sets the fixed value as

NR = NTB+INT-NTR

196. NRAN1

local variable
set DFES
output channel
used Gauran
set Parin

NRAN1 is set by DFES and Parin as

NRAN1 = Ø

197. NRAN2

local variable
set DFES
output channel
used Gauran
set Parin

NRAN2 is set by DFES and Parin as

NRAN2 = Ø

198. NRB

common block
used initialize parameters
used & output update input
used interpolator
used noise filter
used key
used sync
used Fwate
set & used Parin

pages 3-11 back, 3-13, 3-19, 3-37 to 3-39, 3-41 to 3-43, 3-81, 3-82, 3-87, 3-89, 3-93, 3-94)

Number of Receiver Samples per Bit Symbol

NRB is set to the fixed integer value

NRB=RSR/BSR

It is used by the Initialize Parameters Subprogram to compute the size NY of the forward filter output array Y and by the Update Input subprogram to compute the size NS of the interpolator input array S

NY=NRB

NS=NRB=NSPAN

In the noise filter subprogram it is the number of XFREQ (K,I), K = 1,2,---NRB, values generated.

The SYNC subroutine uses NRB to set the size of the ALPHA array

LIMIT=NPN+NRB-1

where NRB is the number of new ALPHA values generated.

The number of PN sequence values to be generated by KEY is I = NRB and the number of interpolator output x values used in computing RSYNC.

199. NRC

common block
output update input
used Sync
set Parin
used Bfilt
used Key

pages (3-17 back, 3-13, 3-19, 3-93, 3-94, 3-97)

Number of Receiver Samples per Chip Symbol

The constant NRC is defined in Parin as NRC=RSR/CSR. It is used by the KEY subroutine as the number of PN sequence duplications.

The BFILT subroutine uses NRC as part of the PN index in computing the ALPHA and GBACK arrays.

200. NRD

local variable
set & used Taper (Both)

pages (3-63, 3-66)

For IBS=1 only, the number of forced delay samples is set (NRD=5).

Later set to NRD=NRD-1

201. NREC

local variable
used DFES

202. NRP

local variable
set & used Taper (Rgen)

pages (3-66)

NRP = NTR*RSR/CSR, Number of tape samples per chip symbol.

203. NRQ

local variable
set & used update input
used chanel

Update input sets NRQ as

NRQ = ø

and

NRQ = INT - NTR

204. NS

common block pages (3-14 back, 3-16, 3-19)
set DFES
set, used, & output update input
used interpolator
used Fwate

Interpolator Array Size

NS is the fixed integer dimension of the Interpolator arrays S and X. The Update Input subprogram sets

NS=NRB+NSPAN

NX=NS

NS has the range $1 \leq NS \leq 500$ as set in DFES

205. NSHIFT

local variable pages (3-18, 3-42)
set DFES
set, used, & output update input

The NSHIFT parameter is computed. The purpose of this parameter is to maintain synchronization for the nondispersive channel for any forward filter tap specification.

NSHIFT = NTR*ISET(1).

NSHIFT is set to Ø by DFES.

206. NSPAN

common block pages (3-9, 3-10 back, 3-18, 3-19)
set DFES
set, used, & output update input

Forward Filter Span

In receiver sample widths DFES sets NSPAN = Ø

NSPAN is an integer set to the fixed value

$$NSPAN = \underset{I}{MAX}\ ISET\ (I) = ISMAX$$

by the update Input subprogram where it is used to compute the size NS of the Interpolator arrays S and X

NS=NRB+NSPAN

207. NTAP

common block
used initialize parameters
used update input
used forward filter
used differential decoder
set, used & output Sync
set, used, & output Parin
used Fwate
used Bfilt

pages (3-13 back, 3-13, 3-16, 3-20, 3-41, 3-52, 3-54, 3-55, 3-58, 3-59, 3-83, 3-84, 3-87, 3-89, 3-90, 3-92, 3-96, 3-98)

Number of Forward Filter Taps

NTAP is a fixed integer parameter to the subroutine PARIN with a default of 1. It defines the size of the forward filter arrays ISET and W. The subroutine FWATE uses NTAP to set the size of the Kalman algorithm arrays VKAL and PVAR.

NLTAP=NTAP+LTAP

FWATE also uses NTAP as an index indicator in computing the variable CON for NALG=2.

The Backward Filter subroutine uses NTAP in the index for the VKAL array when KLMS=0.

The Initialize Parameters subprogram uses NTAP when NALG=2 and SMODE=1 to set the adaptation delay to KALA=2*NTAP iterations.

Sync sets NTAP = NTAP + 1 if MOD (NTAP, 2) $\neq$ Ø.

208. NTAP1

local variable
set & used Sync

Sync sets NTAP1 to be

NTAP1 = NTAP/2

209. NTAP2

local variable
set & used Parin

Parin sets NTAP2 to be

NTAP2 = 2 * NTAP

210. NTB

Number of channel samples per bit symbol

common block — pages (3-10, 3-11 back, 3-13, 3-15,
used initialize parameters — 3-19, 3-23, 3-24, 3-80)
used & output update input
used Noise
set & used Parin
used channel

Number of Channel Samples per Bit Symbol

NTB is a fixed integer value set by Parin to

NTB=TSR/BSR

where it is used to set

NR=NTB+INT-NTR

and

NQ=NTB+INT-NTR+KSET(CTAP)

Each bit symbol iteration is used to set the number of receiver samples NGEN to be input by TAPER. The Channel subprogram uses NTB in computing the index NPOW and the NOISE subroutine uses it to set the number of noise samples generated in N array.

211. NTR

common block — pages (3-13, 3-15, 3-18, 3-42, 3-80)
used initialize parameters
used Taper (Rgen)
used & output update input
used interpolator
set & used Parin

NTR = TSR/RSR as set by Parin

212. NV

local variable
used noise filter
set & used Taper (Read)
set Pin 1

pages (3-15, 3-63 to 3-65)

Taper (Read) sets NV to

NV=NGEN+NNI

The number of data samples to transfer to the output array, VR, plus the number of data samples to be skipped for bit synchronization and NV = NV - 1.

An integer half-width of the Noise Filter is computed

NV = (MTAP+1)/2 as set in Pin 1.

213. NVIN

common block
set & used Taper (Read)

pages (3-13 back, 3-63, 3-64)

Receiver Sample Pointer

NVIN is an integer variable used by the Tape Read subroutine TAPER (file name READ) as the pointer to the consecutive receiver samples in the input data block array VIN. When IBS=1, NVIN is initialized to 0 in Taper (Read).

The data sample pointer is set (NVIN=0).

Later updated NVIN = NVIN + 1

214. NX

common block
set DFES
set update input
used interpolator
used noise filter
used forward filter

pages (3-12 back, 3-19, 3-37, 3-39 to 3-42, 3-87)

Noise Filter Output Size

NX is the fixed integer size of the noise filter output array x. The Update Input subprogram sets

NX=NS

DFES sets NX initially.

215. NY

local variable
set initialize parameters
used forward filter
used Key
used compressor

pages (5-3 back, 3-13, 3-44, 3-93, 3-94)

Forward Filter Output Size

The integer size NY of the forward filter output array Y is set by the Initialize Parameters subprogram

NY=NRB.

It is used by the Compressor as a calling sequence argument for KEY to generate NY PN sequence values.

216. ONE

local variable
set & used ERFC

ONE is set by ERFC as

1.DØ in a Data Statement

217. P

local variable
set & used ERFC
set & used key
set & used Taper (Rgen)

pages (3-67, 3-93, 3-94)

The receiver sample P (Complex) is

P = P*EJ.

ERFC sets the value of P in a Data Statement.

218. PI

common block — pages (3-7 back, 3-14, 3-36, 3-92
used initialize parameters — 3-109)
set DFES
used channel
used noise filter
used Bfilt

π

The real constant PI is set by the DFES main program to

PI = 3.14159265.

219. PIX

local variable
set & used Sinc

PIX is set by Sinc as

PIX = PI * X

220. PN

array — pages (3-24 back, 3-36, 3-39, 3-81,
used noise filter — 3-82, 3-88, 3-89, 3-94, 3-96,
used Sync — 3-97)
used Fwate
used Bfilt
set Key

Pseudo-Noise Sequence Array

The complex array PN(K), K-1,2,--NY generated each bit symbol iteration by the subroutine KEY. It is a calling sequence argument of the subroutines KEY, SYNC, BFILT, and FWATE.

The Noise Filter subprogram uses PN in computing the array V. The Compressor subprogram uses it to compute the compressor output Z. SYNC uses PN to compute the array ALPHA and FWATE to compute the S BAR array. PN is used in BFILT for setting the ALPHA and GBACK arrays.

Key sets PN(N) = CONJG(P)

221. POW

array
set DFES
used channel
set & output Parin

pages (3-25 back, 3-13, 3-17, 3-22
3-54, 3-60)

Channel Relative Power Array

POW is a real array of the subroutine PARIN dimensioned POW(4). Its default is POW(1)=1, POW(I)=0, I=2,3,CTAP. It is the relative power of path I with respect to the first path. It is used by the Channel subprogram for the variance CVAR used in the channel random number generation by GAURAN

```
CVAR = POW(J)/2
```

222. PSK

common block
used detector
set, used, & output Parin

pages (3-2 back, 3-45, 3-46, 3-48, 3-54, 3-57)

Number of Transmitted Phases

PSK is an integer of fixed value 2 or 4. It is used by the Detector as an indicator to determine the value of AHAT. PSK is an input parameter to the subroutine PARIN with the default PSK = 2.

223. PVAR

virtual array
set, used, & output Fwate

pages (3-89 to 3-91)

The inverse matrix estimate PVAR

The Kalman matrix PVAR is updated.

PVAR is set by Fwate to

```
PVAR(I,J) = (4.,Ø.)

 if I = J   PVAR(I,J) = (1.,Ø.)

PVAR(I,I) = PVAR(I,I)*AKC-RCON*(CABS(VKAL(I))**2)

PVAR(I,J) = PVAR(I,J)*AKC-RCON*VKAL(I)*CONJG(VKAL(J))

PVAR(J,I) = CONJG(PVAR(I,J))
```

224. Q

virtual array pages (3-22 to 3-24, 3-27)
set & used channel

Every bit symbol iteration, the subprogram receives a transmit signal array

Q(K) = Input array to the subprogram (Complex).
K = 1, 2, ... NQ. NQ $\leq$ 330.
NQ=NTB+INT-NTR+KSET(CTAP).

the most recent input values (Q array)

Q(K) = Q(K-NTB) K = NTB + 1, ... NQ

Q(K) = CMPLX(VR(1,K),VR(2,K)

225. QE

local variable
set & used detector

QE is set by the detector as

QE = AIMAG(E)

QE = SIGN (1., QE)

226. QN

local variable
set & used Sync
set Parin

QN is set by Sync as

QN = 6ØØØ. * RANGE * (1.E-9) * RSR

QN is set by Parin as

QN = 6ØØØ. * (1.Ø E-9) * RSR

227. QS

local variable
set & used interpolator

The interpolator sets QS as

QS = (Ø.Ø, Ø.Ø)

QS = QS + GCON * R (NTR * K + I + INT1 + (1-NTR)) * SINK(IQ)

228. QW

local variable
set & used Fwate
set & used Bfilt

QW is set by Fwate as

QW = AIMAG(W(I))

QW = 100. * SIGN(1.QW)

QW is set by Bfilt as

QW = AIMAG (BETA(I))

QW = 1ØØ. * SIGN(1., QW)

229. R

array — pages (3-14, 3-23 to 3-27, 3-29, 3-30 to 3-33)
set DFES
set, used, & output channel
used interpolator
output detector

R is the receiver input array

DFES sets (R(I) = (Ø.Ø, Ø.Ø)

Channel sets R to

R(K) = (Ø.Ø.)

R(K) = R(K) + H(I) * Q (K#SET(I))

R(K) = R(K) + N(K)

where K = 1, NTB + NRQ

230. RANGE

common block — pages (3-7 back, 3-55, 3-58, 3-81, 3-86)
set DFES
used & output Sync
set, used, & output Parin

Range in Nautical Miles

RANGE is an input parameter to PARIN only if the bit synchronization routine SYNC is to be used (NA > 0). It is used by SYNC to compute the number of PN sequence values range used in synchronization NPN. The default is RANGE = 300. DFES initially sets RANGE = Ø.Ø.

231. RATE

local variable — pages (3-52)
set, used, & output differential decoder

RATE = Bit error rate (Real).

The error rate (RATE) is computed as the number of bit errors divided by the total number of received bits.

The differential decoder sets

```
RATE = ERROR/(RNUM *2)
```

and if REF = 1 then

```
RATE = RATE * 2
```

232. RCON

local variable — pages (3-91)
set & used Fwate

```
RCON=KSTEP*AKC.
```

233. RDEL

local variable
used detector
set Pin1

Pin 1 sets RDEL as

```
RDEL = 2. * PI * RGLB/BSR
```

234. RE

local variable
set & used detector

RE is set in the detector to

RE = REAL(E)

RE = SIGN(1., RE)

235. REF

common block
set update input
used detector
used differential decoder
set, used, & output Parin
set Fwate

pages (3-2 back, 3-11, 3-15, 3-45 to 3-50, 3-54, 3-57, 3-92)

Presence or Absence of Reference Signal Indicator

REF is an integer input parameter to PARIN of value 0, 1, 2, or 3.

PARIN uses the input value of REF to set the differential decoder indicator IDEC. The value of REF remains constant for NALG = 1 or NALG = 3. When NALG = 2, the subroutine FWATE modifies REF in the Kalman algorithm adaptation to the following:

REF = 3 for KNUM = KVAR

REF = 0 for KNUM = KEND

When REF = 3 and NALG = 2, the Detector sets AHAT = A. The Detector also uses the current value of REF as an indicator for setting the adaptation error sample E.

236. RGAIN

local variable
set DFES
set, used, & output detector

RGAIN is set by DFES as

RGAIN = (1.Ø, Ø.Ø)

RGAIN is set in the detector to

RGAIN = RGAIN + RDEL * E * CONJG(Z)

237. RGLB

Rake gain loop bandwidtn in HZ, default = 5

common block
set, used, & output Parin
used Pinl

Parin sets RGLB to

RBLB = 5.Ø or some other number

if RGLB = Ø then RGLB = 5.Ø

238. RIBS

Number of bit Symbol iterations including Sync

common block
set DFES
set, used, & output update channel
used interpolator
used detector
used noise filter
used Noise
used Key
set, used, & output Sync
set Taper (Read)
used Taper (Rgen)

RIBS is set as

RIBS = Ø.Ø in DFES

Update input sets RIBS to

RIBS = RIBS + 1

239. RJBS

local variable
set & used channel

Channel sets RJBS to

RJBS=RIBS

If RJBS > 1.E+4 then RJBS = 1

240. RKAL

local variable
used update input
set Pin1

RKAL is set by Pin 1 as

RKAL = FLOAT (KRST/KADAPT)

241. RKBS

local variable
set & used noise filter

The noise filter sets RKBS as

RKBS = RIBS

RKBS = RNUM if SMODE = 1

242. RKIBS

local variable
used forward filter
set & used detector

243. RKIPS

local variable
set DFES

RKIPS is set by DFES to

RKIPS = Ø.Ø

244. RMAX

local variable
set, used, & output Sync

Sync sets RMAX to

RMAX = Ø.

RMAX = RS(IMAX)

245. RNBS

Real number of bit symbol iterations to do after Sync

common block
used differential decoder
set & output Parin

RNBS is set by Parin to a number desired for the number of bits, example:

1,ØØØ, 1Ø,ØØØ, etc.

246. RNEXT

local variable
set & output Sync

Sync sets RNEXT to

RNEXT = Ø

RNEXT = RS(INEXT)

247. RNUM

Number of bit symbol iterations after Sync

common block
set DFES
set update input
set & used channel
used noise filter
used detector
used & output differential decoder
used Bfilt

RNUM is set RNUM = Ø.Ø in DFES
and
Update Input Channel sets RNUM to

RNUM = RNUM + 1

248. RS

array pages (3-83)
set, used, & output Sync

Comparision is made on the magnitude of the correlator output

RS(I) = CABS(RSYNC(I))

249. RSR

common block
used initialize parameters
used noise filter
used Taper (Rgen)
used Sync
set, used, & output Parin
used Pin 1

pages (3-4 back, 3-12, 3-24, 3-29, 3-30, 3-36 to 3-38, 3-51, 3-55, 3-58, 3-66, 3-72, 3-80, 3-86)

Receiver Sample Rate in Hz

RSR is a real input constant to the PARIN subroutine. It has a default value of 96K and must be an integer multiple of BSR.

RSR is used by the Initialize Parameters subprogram in computing NRB, NRC, NTR, and the noise filter adaptation delay IX.

In the Noise Filter subprogram it is used in computing the constant

$$\text{ALPHA} = \frac{\pi}{\sqrt{2}} \left(\frac{\text{BRF}}{\text{RSR}}\right)$$

and the variable

$$C_x = 2\pi\left(I - \left(\frac{\text{MTAP}+1}{2}\right)\right)\left(\frac{\text{FSPACE}}{\text{RSR}}\right),\ I = 1, 2, \text{-- MTAP}$$

When all bit symbol iterations have been completed, RSR is used in computing the measured SNR

$$\text{SNRM} = 10 \log_{10} (\text{SPOW*TSR/(*BSR*(SIGMA**2)))}$$

The SYNC subroutine uses RSR in computing the number of PN sequence range values used in bit synchronization

$$\text{NPN} = 6000*\text{RANGE}*\text{RSR}*10^{-9}$$

250. RSYNC

array pages (3-25 back, 3-82, 3-83)
set & used Sync

Bit Synchronization Array

RSYNC is a complex array computed by SYNC of size

NPN=6000*RANGE*10^{-9}*RSR where NPN $\leq$ 180.

SYNC uses it as the calling sequence input array for the subroutine MAX.

SYNC sets RSYNC(I) = (Ø.,Ø.)

RSYNC(I) = RSYNC(I) + X(J) * ALPHA(J+NI)

251. RTHOLD

common block
used forward filter
set, used, & output Parin

Rate threshold in dB down from maximum weight, default = 12

Parin sets RTHOLD as

RTHOLD = 1Ø.**(-RTHOLD/2Ø.)

and

if RTHOLD = Ø then RTHOLD = 12

252. RW

local variable
set & used Fwate
set & used Bfilt

RWIS set by Fwate as

RW = REAL(W(I))

RW = 1ØØ.*SIGN(1.,RW)

RW is set by Bfilt as

RW = REAL (BETA(I))

RW = 1ØØ.*SIGN(1.,RW)

253. S

Interpolator output array

a) Virtual array pages (3-16, 3-30 to 3-33, 3-37)
set, used, & output interpolator
used noise filter

The interpolator sets S as

$$S(K) = S(K-NRB) \text{ where } K = NS, NRB+1, -1$$

$$S(K) = QS \text{ where } K = 1, NRB$$

b) array pages (3-105)
set Gauran
used Noise

The real and imaginary parts of the complex number are then formed

$$S(1) = (-2\ V\ \log_e A)^{\frac{1}{2}} \cos(2\pi B)$$

$$S(2) = (-2\ V\ \log_e A)^{\frac{1}{2}} \sin(2\pi B)$$

S(1) = Real part of the complex number

S(1) = Imaginary part of the complex number

Gauran sets S to S corresponds to XC

$$S(1) = X*COS(Y)$$

$$S(2) = X*SIN(Y)$$

254. SBAR

array pages (3-89)
set & used Fwate

weight input voltage after compression

$$SBAR(I) = \sum_{K=1}^{NRB} \overline{PN}(K)*\overline{X}(ISET(I)+K)$$

255. SCALE

local variable
set & used Taper (Read)

Taper (Read) sets SCALE as

```
SCALE = 1.ØE-4
```

256. SDC

local variable
set noise filter

SDC is set in the noise filter as

```
SDC = Ø.
```

257. SI

local variable
set & used detector

The detector sets SI as

```
SI = SIGN(1.Ø, AIMAG(ZC)
```

258. SIGMA

local variable
set initialize parameters
used channel
set Noise

pages (5-3, 5-4 back, 3-18, 3-25, 3-49, 3-51, 3-77, 3-79, 3-80)

Standard Deviation σ of a Quadrature Component of the Complex Noise Sample N

SIGMA is a real constant set to

```
SIGMA = SQRT(TSR/(BSR*2.*SNR))
```

by the Initialize Parameters subprogram and NOISE subroutine

In Noise it is set to

```
SIGMA = SQRT(SVAR)
```

The Channel subprogram uses it to form the noise array N

$N(K) = 0+j\sigma$

when NOZDC = 1.

259. SINC

local variable
used Sinc
set update input

pages (3-109)

The function SINC(X) is defined as

$$SINC(X) = \frac{\sin \pi x}{\pi x} \text{ , for } x \neq 0$$

$$= 1 \text{ , for } X = 0.$$

For X = 0 or $|\sin \pi x| - |\pi x| < 10^{-6}$ the routine returns

```
SINC = 1
```

otherwise

```
SINC = (SIN(PIX))/(PIX)
```

260. SINK

array pages (3-19, 3-29, 3-33)
set & output update input
used interpolator

SINK (I) Array of sin x/x interpolation values (Real).
I = 1,2,...INT.

$$SINK(J) = SINC\left(\frac{J-INT1-1}{NTR} - TI\right)$$

where the SINC(X) function is defined in (3.4.22.).

To speed up the computation, the SINC (·) function is precomputed as an array SINC in the subprogram UPDATE INPUT (3.4.2) as follows

SINC(J) = SINC(I/NTR-TI), I = -INT1, ... INT1

J = I+INT1+1.

SINK(J) = SINC(XX)

261. SIX

local variable
set & used initialize parameters

SIX is set in initialize parameters to

SIX = 3.*RSR/(2.*PI*NFLB*NRB)

262. SKIP

common block
used detector
used differential decoder
used channel
used noise filter
used & output Fwate
set & used Parin

SKIP is set in Parin to the number of bits to be skipped during printout according to desired number, example:

SKIP = 1ØØ, 1,ØØØ, or 5,ØØØ

If SKIP = Ø, SKIP = 1ØØ

263. SMODE

local variable
set & used initialize parameters
used update input
used interpolator
used channel
used noise filter
set Sync

pages (6-1 back, 3-12, 3-14, 3-16, 3-81, 3-83, 3-85)

Bit Synchronization Mode

SMODE is the integer synchronization mode indicator. Its values are 0 or 1. When SMODE = 0 bit synchronization is performed by SYNC for IBS=NA iterations until the acquisition decision is obtained. When SMODE=1, the acquisition decision has been made and SYNC is not used. The Initialize Parameters subprogram sets SMODE=0 for NA>0 and SMODE=1 for NA=0. The subroutine sets SMODE=1 after NA iterations when it makes the acquisition decision. SMODE is a calling sequence argument of the subroutine SYNC.

264. SNR

common block
set & used initialize parameters
used Noise
set & output Parin

pages (4-6 back, 3-18, 3-53, 3-58, 3-72, 3-74 to 3-78)

Signal to Noise Ratio

SNR is the real variable input parameter of the signal to noise ratio in dB for the subroutine PARIN. The Initialize Parameters subprogram converts it to

```
SNR=10.**(SNR/10.).
```

SNR is a calling sequence argument for the NOISE subroutine where it is used to compute the variance SVAR for the random number generator GAURAN.

265. SNRM

local variable
set & output differential decoder

pages (3-52)

SNRM = Measured signal-to-noise ratio in dB (Real).

It is also printed. The measured signal-to-noise ratio expressed in dB is calculated as

```
SNRM = 10.*ALOG10(SPAW*TSR/(2.*BSR*(SIGMA**2)))
```

266. SPAW

local variable
set DFES
set & used channel
used differential decoder

DFES sets SPAW to

```
SPAW = 1.Ø
```

The channel sets SPAW to

```
SPAW=(1.-1./RNUM)*SPAW+((CABS(R(NPOW)))**2)/(2.*RNUM)
```

267. SPOW

local variable pages (3-14, 3-24, 3-25, 3-49, 3-51)
set DFES
set & used channel
output detector
used differential decoder

DFES sets SPOW as

```
SPOW = 1.
```

Receiver input power per quadrature channel and recursively computing every IBS iteration in channel is

```
SPOW = (1.-ASTEP)*SPOW+ASTEP*((CABS(R(NPOW)))**2)/2
```

The measured signal power is recursively computed as

```
SPOW = ((NUM-1)*SPOW+CABS(R(NPOW))**2)/NUM
```

which is mathematically equivalent to

$$SPOW = \frac{1}{NUM} \sum_{I=1}^{NUM} |R_I|^2$$

where the R_I are independent samples of the signal.

268. SQ2

local variable pages (3-14)
set initialize parameters
used channel
used noise filter

$SQ2 = \sqrt{2}.$

269. SR

local variable
set & used detector

The detector sets SR to be

```
SR = SIGN (1.Ø, REAL (ZC))
```

270. SUM

local variable
set & used ERFC
set & used Sync
set & used Semul

Sync sets SUM as

```
SUM = SUM + CABS(W(I))**2
```

ERFC sets SUM to be

```
SUM = Ø
SUM = SUM + A(I)*(T**I)*DEXP(-(X**2))
```

Semul sets SUM as

```
SUM = Ø.
SUM = SUM+((AL*ARG)**J)/JFACT
```

271. SUM1

local variable
set & used Noise

SUM1 is set by Noise to

```
SUM1 = 1
```

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DECISION-FEEDBACK EQUALIZER SIMULATION (DFES) - DESCRIPTION OF --ETC(U)
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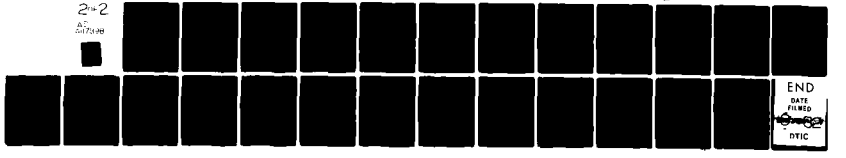

272. SVAR

local variable pages (5-4 back, 3-105)
used Gauran
set & used Noise

Gaussin Random Number Generator Variance

SVAR is the real variance computed by NOISE and used in the call to Gaussian random number generator GAURAN

SVAR = TSR/(2.BSR*SNR)

273. T

local variable
set & used ERFC

$T = (1+.3275911*X)^{-1}$

T = ONE/(ONE+P*X)

274. TEMPF

local variable
set & used detector

The detector sets TEMPF as

TEMPF = AIMAG(F)

275. TI

common block
set DFES
output update input
set & output Sync
set Parin

pages (3-8 back, 3-11, 3-17, 3-19, 3-33, 3-55, 3-58, 3-83)

Timing Interval

When bit synchronization is required (NA > 0 and SMODE=0), the initial value of TI is 0 and the final TI value is computed by the subroutine SYNC. If bit synchronization is not used, TI is an input parameter to the subroutine PARIN. TI is a real variable with the range

$$-1 \leq TI \leq 1$$

Once computed by SYNC or input by PARIN, TI remains constant.

Sync sets TI as

TI = TOP/(RMAX*2.) and TI = Ø

TI is used to compute the SINK array for the Interpolator subprogram.

DFES sets TI = Ø.Ø

276. TOP

local variable
set & used Sync

Sync sets TOP as

TOP = RS(IMAX+1) if IMAX = 1

TOP = RS(IMAX-1) if IMAX = NPN

TOP = RS(IMAX+1)-RS(IMAX-1) if IMAX >1 and IMAX <NPN

277. TSR

common block
used initialize parameters
used differential decoder
set, used, & output Parin
used Noise

pages (3-4 back, 3-12, 3-18, 3-23, 3-25, 3-29, 3-49, 3-55, 3-57, 3-58, 3-66)

Tape Sample Rate in Hz

TSR is a real input constant to the PARIN subroutine. It has a default value of 192K and must be an integer multiple of BSR.

TSR is used by the Initialize Parameters subroutine in computing NTB, SIGMA, the number of tape samples per receiver sample NTR = TSR/RSR, and the channel tap integer array KSET(I)=TSR*DELAY(I)+0.5. The NOISE subroutine uses it to compute the variance

SVAR = TSR/(2*BSR*SNR)

and

SIGMA = $\sqrt{TSR/(2*BSR*SNR)}$

278. V

array
set DFES
set, used, & output noise filter
set & output Parin

pages (3-25 back, 3-12, 3-17, 3-37, 3-39, 3-40, 3-54, 3-59)

Noise Filter Array

V(I), I=1,2,---MTAP is a complex array used by the Noise Filter subprogram in computing the noise filter output array X when MTAP>1. It has a maximum size V(25). V is initialized by PARIN where it is re-defined as a real array (V(50). When MTAP>1, V may be optionally initialized as an input parameter array to PARIN. The Default values are V(I)=0, I=1,2,---MTAP.

DFES sets V as

V(I) = (Ø.Ø, Ø.Ø)

The Noise filter sets V as

V(I) = V(I)-VSTEP*F*CONJG(CJ)

279. VIN

virtual array
set & used Taper (Read)

Complex data samples array

```
VIN(1,J) = FLOAT(IDATA(I))*SCALE

VIN(2,J) = FLOAT(IDATA(I+1))*SCALE
```

280. VKAL

array
set, used, & output Fwate
used Bfilt

pages (3-25 back, 3-89, 3-91, 3-92, 3-96, 3-98)

Kalman Update Vector

VKAL(I), I=1,2,---NLTAP is a complex array computed by FWATE for use in updating the weight vector W and array PVAR when NALG=2. BFILT also uses VKAL to update BETA when NALG=2. VKAL is a calling sequence argument of FWATE and BFILT and has a maximum size VKAL(50).

Fwate sets VKAL to

```
VKAL(I) = (Ø.Ø.)

if J>NTAP then

VKAL(I) = VKAL(I)+PVAR(I,J)*GBACK(JSET(J-NTAP))

if J≤NTAP then

VKAL(I) = VKAL(I)+PVAR(I,J)*SBAR(J)
```

281. VMAX

local variable
set DFES
set & used noise filter

DFES sets VMAX to

```
VMAX = Ø.Ø
```

The noise filter sets VMAX to

```
VMAX = Ø

VMAX = CMAG if CMAG > VMAX
```

282. VR

array
used channel
set Taper (Read)

Receiver Sample Input Array

VR is the receiver sample array returned by TAPER each bit iteration. VR is defined as a real array dimensioned CV(2,100) where (VR1,I) = real sample part and VR(2,I) = imaginary sample part. It is used to set the transmit signal array for the Channel subprogram

```
Q(K) = CMPLX(VR(1,K),VR(2,K),

  k = 1,2,---NTB+NRQ
```

When IBS=1, TAPER (READ) returns NR samples in VR. For IBS > 1 NTB samples are returned.

```
VR(1,NV) = Ø

VR(2,NV) = Ø

VR(1,I) = VIN(1,NVIN)

VR(2,I) = VIN(2,NVIN)

VR(1,NV) = VIN(1,NVIN)

VR(2,NV) = VIN(2,NVIN)
```

283. VSTEP

local variable
set, used, & output noise filter

Adaptation algorithm step size

```
VSTEP = 2.*PI*NFLB*RSR/(BSR*BRF*NRB)
```

284. W

array
set DFES
output update input
used forward filter
output differential decoder
set & used Sync
set & used Fwate
set Parin

pages (3-26 back, 3-17, 3-19, 3-41, 3-42, 3-52, 3-53, 3-59, 3-87, 3-89, 3-92)

Forward Filter Weight Vector

W(I),I=1,2,---NTAP is an input parameter array to the subroutine PARIN, with the default W(1)=1, W(I)=0, I=2,3,--NTAP2. W has a maximum dimension of 25. The array W is updated each bit symbol iteration by FWATE using either the Kalman or LMS algorithm. W is used in computing the forward filter output array Y.

Sync sets W to

W(I) = CONJG(RSYNC(2*IMAX-ISET(I)/RSYNC(IMAX))

FWATE sets W to

W(I) = CMPLX(RW,QW)

285. WMAX

local variable
set & used forward filter

The forward filter sets WMAX to

WMAX = Ø.

WMAX = CABS(W(I)) if CABS(W(I))≥WMAX

WMAX = WMAX*RTHOLD

286. WMULT

local variable
set & used Fwate

WMULT is set by Fwate to

WMULT = 1.

WMULT = 1.-DELTA if ALGOR = 4

287. X

a) virtual array pages (3-16, 3-37 to 3-40)
set & used interpolator
set, used, & output noise filter
used forward filter
set & used ERFC
used Sync
used Fwate

Noise Filter Output

X is a complex array of size NX=NS with a maximum dimension X(500). For MTAP=1 it is formed directly from the Interpolator array S. When MTAP > 1, X is computed by the Noise filter subprogram each bit symbol iteration. It is used in forming the forward filter output array Y.

X is a calling sequence argument of the subroutines SYNC and FWATE. In SYNC it is used in forming the synchronization array RSYNC and FWATE uses it to compute the SBAR array.

The interpolator sets X to

```
X(K) = X(K-NRB)
```

ERFC sets X = Z

The noise filter sets X to

```
X(I) = S(I) where I = 1,NX

X(K) = (Ø.,Ø.)

X(K) = X(K) + V(I) * XFREQ

X(K) = SLK + IBDEL) - X(K)
```

b) local variable pages (4-6 back, 3-70, 3-109)
set & used Gauran
set Dpgen
used Sinc

HSQ SINC Input

Gauran sets X to

```
X = SQRT(-2.Ø*SVAR*ALOG(A))
```

Dpgen sets X to

```
X = CMPLX(D(1),D(2))
```

X is the real variable input to the function SINC

288. XC

local variable pages (4-7 back, 3-27)
used channel

XC corresponds to S in the call to Gauran

Channel Gaussian Random Number

XC is the complex Gaussian random number returned by GAURAN to the Channel subprogram. It is used in updating the complex H array.

289. XERR

local variable
set & used differential decoder

The differential decoder sets XERR to

```
XERR=AERR*XERR+(1.-AERR)*DR  if REF=3
```

290. XF1

local variable
set & used noise filter

291. XF2

local variable
set & used noise filter

292. XFREQ

local variable
set, used, & output noise filter

```
XFREQ = (Ø.,Ø.)

XFREQ = AIX*XF1-CIX*XF2+BIX*S(K)
```

293. XKSET

local variable
set & used Parin

XKSET is set by Parin to

```
XKSET = TSR*DELAY(I)+Ø.5
```

294. XX

local variable pages (4-7 back)
set & used update input

Interpolator SINC Function Input

XX is the real variable input to the function SINC for computing the Interpolator SINK array

XX = FLOAT(I)/NTR-TI

295. Y

array pages (3-41, 3-43, 3-44)
set & used forward filter
used & output compressor

Y(K), Input array (Complex, K=1,2,...NY, NY=NRB $\leq$ 80.

The forward filter sets Y to

Y(K) = (Ø., Ø.)

Y(K) = Y(K) + W(I) * S(J + IBDEL)

Y(K) = Y(K) + W(I) * X(J)

Y(K) = Y(K) - X(K)

296. YC

local variable
set & used channel

YC = HP(J)

297. Z

local variable pages (3-44 to 3-46, 3-50)
set & used compressor
output differential decoder
used ERFC
used detector

Z = COMPRESSOR output (Complex).

The cross correlation operation which accomplishes the bandwidth compression is

$$Z = (NY)^{-1} \sum_{I=1}^{NY} PN(I)*Y(I).$$

Z is initially set

Z = (Ø.,Ø) by the compressor.

298. ZC

local variable pages (3-52)
set & used detector
output differential decoder

Predecision Sample of Detector

The predecision sample is the sum of the compressor and backward filter outputs, viz., as set in the Detector subprogram

ZC = KGAIN*Z+C

299. ZERO

algorithm

local variable
set & used Parin

Parin sets ZERO using a Data Statement to

ZERO = Ø.Ø

CROSS-REFERENCE LIST

KEY

A = set, used, and output

B = set and used

C = used and output

D = set and output

O = output (printed out)

S = set

U = used

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Signatron, Inc Decision-Feedback Equalizer Simulation (DFES) program performance specification, Lexington, MA, July 1978

Signatron, Inc HF Channel Adaptive Equalization Algorithm interim technical report, contract N66001-77-C-0248, Lexington, MA, December 2, 1977

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	INITIALIZE PARAMETERS	Update Input	Channel	Interpolator	Boxcar Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
BC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
BDEL	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BETA	array	B	—	—	—	—	—	—	S	—	—	—	—	—	S	—	0	—	—	—	—	—	—	0	—	—
BFLB	common block	U	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BIX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
BKC	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
BRF	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—
BRRR	array	—	—	—	—	—	—	—	A	—	—	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—
BSR	common block	U	—	U	—	—	—	U	A	U	—	—	—	—	—	U	—	U	—	U	—	—	—	U	—	—
BSTEP	local variable	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C	local variable	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	D	—	—
CAS	local variable	—	—	—	—	—	—	—	D	—	—	—	—	—	S	—	—	—	—	U	U	—	—	—	—	—
CC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
CIX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
CJ	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
CLEAR	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CMAG	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
CN	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
CON	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CSR	common block	—	—	—	—	—	—	—	A	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—
CTAP	common block	—	—	—	—	—	—	—	A	—	—	—	—	—	—	U	—	U	—	—	—	—	—	—	—	—
CVAR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—
CX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS											FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		SFLIT	SPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	[illegible]	Update Input	Channel	Interpolator	Noise Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
A	local variable	—	—	—	B	—	—	—	—	—	—	B	—	B	S	—	—	—	—	—	—	—	B	D	—	—
A	array	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—
A1	local variable	—	—	—	—	—	—	—	—	—	—	B	—	B	S	—	—	—	—	U	—	—	B	—	—	B
A2	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B
AC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
ABATA	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ADR	local variable	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AERR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	U	—	—
AGCLB	common block	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AGCLG	local variable	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AHAT	local variable	U	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	B	C	—	—
AHAT1	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	S	—	—	—	B	—	—
AIX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
AKC	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AL	local variable	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ALGOR	local variable	—	—	U	—	—	—	—	B	—	—	—	—	—	—	B	—	U	—	—	U	—	U	U	—	—
ALPHA	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—
ALPHA	virtual array	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ALPHA	array	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AMAX	local variable	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AN	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
ARG	local variable	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ASTEP	local variable	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—
B	local variable	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	[illegible] PARAMETERS	Update Input	Channel	Interpolator	Noise Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
B	local variable	—	B	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	B	C	—	—
BC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
DELAY	array	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DELTA	local variable	—	—	U	—	—	—	—	—	S	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—
DERR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—
DHAT	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	A	—	—
DOP	array	—	—	—	—	—	—	—	A	—	—	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—
DR	local variable	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—
DRATE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	D	—	—
E	local variable	U	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	B	—	—	—
EBER	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—
EC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
EDC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
EDEL	local variable	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	—	—
EJ	local variable	—	—	—	—	B	—	—	—	—	—	B	—	B	—	S	—	—	—	—	—	—	U	U	—	—
EMSE	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
EMUL	array	—	—	—	—	—	—	—	—	—	D	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
ERFC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—
ERROR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	A	—	—
ESNR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—
ESTEP	local variable	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—
F	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	B	D	—	—
FFLB	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FIX	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS											FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	BPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (AGEN)	DFES	INITIALIZE PARAMETERS	Update Input	Channel	Interpolator	Noise Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
FSPACE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—
GBACK	array	S	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
GCOM	common block	—	—	—	—	—	—	—	B	—	—	A	—	—	S	—	0	B	U	—	—	—	0	—	—	—
H	array	—	—	—	—	—	—	—	A	—	—	—	—	—	S	—	—	A	—	—	—	—	—	—	—	—
HD	array	—	—	—	—	—	—	—	S	—	—	—	—	—	S	—	—	B	—	—	—	—	—	—	—	—
HP	array	—	—	—	—	—	—	—	S	—	—	—	—	—	S	—	—	B	—	—	—	—	—	—	—	—
I	local variable	B	B	B	—	—	B	B	E	B	A	B	B	—	U	B	B	—	B	B	A	A	—	B	B	—
IBDEL	local variable	—	—	U	—	—	—	—	—	S	—	—	—	—	—	—	C	—	—	—	U	—	—	—	—	—
IBETA	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IBLOCK	local variable	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—
IBMMS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
ICH	array	—	—	—	—	—	—	—	—	S	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—
ICHAR	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—
ICHIP	array	—	—	—	—	U	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ICHP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—
IDATA	array	—	—	—	—	—	—	—	—	—	—	—	C	—	—	—	—	—	—	—	—	—	—	—	—	—
IDEC	common block	—	—	—	—	—	—	—	S	—	—	U	—	U	—	—	—	—	—	—	—	—	U	U	—	—
IDEL	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
IDOP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
IEOF	local variable	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
IEOT	local variable	—	—	—	—	—	—	S	—	—	—	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—
IERR	local variable	—	—	—	—	—	—	—	—	—	—	—	A	—	S	—	—	—	—	—	—	—	U	B	—	—
IFIX	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IH	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS											FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	OFES	[illegible]	Update Input	Channel	Interpolator	Beam Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
H	float variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
IK	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IL	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IMAX	local variable	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IMIN	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INC	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INCN	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INEXT	local variable	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
INT	common block	—	—	—	—	—	—	—	A	—	—	—	—	—	—	U	U	—	—	—	—	—	—	—	—	—
INT1	common block	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	U	—	U	—	—	—	—	—	—	—
INV	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—
IPLUS	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IPOS	local variable	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
IPRIN	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	U	U	U	—	U	—	—	—	—
IQ	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—
IQSET	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	B	—	—	S	—	—	—	—	—	—
IRAKE	local variable	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ISET	array	—	—	U	—	—	—	B	—	—	—	A	—	—	—	U	C	—	—	—	C	—	—	—	—	—
ISMAX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—
ISNR	local variable	—	—	—	—	—	—	U	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
IT	local variable	—	—	—	—	—	—	—	—	U	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—
ITRY	local variable	—	—	—	—	—	—	B	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
IW	local variable	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	INITIALIZE PARAMETERS	Update Input	Channel	Interpolator	Noise Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
IX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	D	—	—	—	U	—	—	—	—	—	—
IXF	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—
J	local variable	B	B	B	—	—	B	—	B	—	B	B	B	—	—	—	B	B	—	B	A	—	—	—	—	—
JBLOCK	local variable	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—
JBS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
JFACT	local variable	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JH	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JL	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JMAX	local variable	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JP	local variable	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JRAN1	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
JRAN2	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
JSET	array	C	—	U	—	—	—	—	S	—	—	A	—	—	S	—	—	—	—	—	—	—	—	—	—	—
JTIME	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	S	—	U	—	—	—	—	—	—	U	—	—
JWORD	array	—	U	—	—	—	—	—	—	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
JWORD	common block	—	U	—	—	—	—	—	—	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K	local variable	—	B	B	—	—	—	—	—	—	—	B	B	—	—	—	—	B	B	A	A	—	—	—	—	—
KADAPT	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	—	U	—	U	U	—	—
KAL	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
KALA	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	B	—	U	—	—	—	—	—	—	—	—
KEND	common block	—	—	U	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
KFLB	common block	—	—	U	—	—	—	—	B	—	—	—	—	—	S	U	U	—	—	—	—	—	U	—	—	—
KKN	common block	—	—	B	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
KLMS	common block	U	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	* DFES	INITIALIZE PARAMETERS	Update Input	Channel	Interpolator	Norm Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
KNUM	common block	—	—	A	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
KRST	common block	—	—	U	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	—	—	—	U	U	—	—
KSET	array	—	—	—	—	—	—	—	D	—	—	—	—	—	S	U	—	U	—	—	—	—	—	—	—	—
KSTEP	local variable	U	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
KSYNC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	U	—	—	S	—	—	—	—	—	—
KVAR	common block	—	—	U	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LIMIT	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LM	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LMS	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LOUT	common block	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
LP	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LPO	local variable	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—
LRC	local variable	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LRP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—
LTAP	common block	U	—	U	—	—	—	—	A	—	—	A	—	—	—	—	—	—	—	—	—	—	U	U	—	—
LTAP1	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LTAPE	local variable	—	—	—	—	—	—	—	—	—	—	U	B	S	—	—	—	U	—	—	—	—	U	—	—	—
M	local variable	—	—	—	—	—	S	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MA	array	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MES	array	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MESS	array	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MH	local variable	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MI	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MODE	local variable	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURA®	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	* DFES	INITIALIZE PARAMETERS	Update Input	Channel	Inter-polator	Mono Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
BR	local variable	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MSE	local variable	U	—	B	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	A	—	—
MSELB	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MSET	array	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MSIGN	local variable	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MSYNC	array	—	—	—	—	—	—	—	—	—	—	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MTAP	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	U	—	—	U	—	—	—	—	—	—
MULT	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—
MWORD	array	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	local variable	—	—	—	—	B	U	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	—
N	array	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—
NA	local variable	—	—	—	—	—	—	—	S	U	—	A	—	—	—	U	—	—	—	—	—	—	—	—	—	—
NALG	common block	—	—	U	—	—	—	—	B	—	—	—	—	—	—	B	U	S	—	—	—	—	B	U	—	—
NBLOCK	local variable	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	—
NBYTE	local variable	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	—
NCB	common block	U	—	—	—	—	—	—	S	—	—	—	—	U	—	—	O	—	—	—	—	—	—	—	—	—
NCTAP2	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NFLB	common block	—	—	—	—	—	—	—	A	—	—	—	—	—	—	U	—	—	—	B	—	—	U	—	—	—
NGEN	local variable	—	—	—	—	—	—	—	—	—	—	—	U	U	—	—	B	—	—	—	—	—	—	—	—	—
NI	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NIN	local variable	—	—	—	—	—	—	—	U	B	—	—	—	—	S	B	—	—	—	—	—	—	—	tt	—	—
NLTAP	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NN	local variable	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NNI	common block	—	—	—	—	—	—	—	S	—	—	D	—	U	S	—	O	S	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES																SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES		Update Input	Channel	Interpolator	Mean Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
NOSIG	common block	—	—	—	—	—	—	—	D	—	—	—	—	—	—	C	—	U	—	B	—	—	—	U	—	—
DOZDC	common block	—	—	—	—	—	—	—	D	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—
NPD	local variable	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—
NPN	local variable	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NPOW	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	C	—	—	—
NQ	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	D	U	—	—	—	—	—	—	—	—
NR	common block	—	—	—	—	—	—	U	A	—	—	—	U	U	—	—	D	U	—	—	—	—	—	—	—	—
NRAN1	local variable	—	—	—	U	—	—	—	S	—	—	—	—	—	S	—	—	D	—	—	—	—	—	—	—	—
NRAN2	local variable	—	—	—	U	—	—	—	S	—	—	—	—	—	S	—	—	D	—	—	—	—	—	—	—	—
NRB	common block	—	—	U	—	U	—	—	B	—	—	U	—	—	—	U	C	—	U	U	—	—	—	—	—	—
NREC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—	—	—
NRC	common block	U	—	—	—	U	—	—	S	—	—	U	—	—	—	—	D	—	—	—	—	—	—	—	—	—
NRD	local variable	—	—	—	—	—	—	—	—	—	—	—	B	B	—	—	—	—	—	—	—	—	—	—	—	—
NRP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—
NRQ	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	U	—	—	—	—	—	—	—	—
NS	common block	—	—	U	—	—	—	—	—	—	—	—	—	—	S	—	A	—	U	—	—	—	—	—	—	—
NSHIFT	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	A	—	—	—	—	—	—	—	—	—
NSPAN	common block	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	A	—	—	—	—	—	—	—	—	—
NTAP	common block	U	—	U	—	—	—	—	A	—	—	A	—	—	—	U	U	—	—	—	U	—	—	U	—	—
NTAP1	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NTAP2	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NTB	common block	—	—	—	—	—	—	U	B	—	—	—	—	—	—	U	C	U	—	—	—	—	—	—	—	—
NTR	common block	—	—	—	—	—	—	—	B	—	—	—	—	U	—	U	C	—	U	—	—	—	—	—	—	—
NV	local variable	—	—	—	—	—	—	—	—	S	—	—	B	—	—	—	—	—	—	U	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES														SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	BPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	* DFES	INITIALIZE PARAMETERS	Update Input	Channel	Inter-polator	Mean Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
BVIN	common block	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
BX	common block	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	S	—	U	U	U	—	—	—	—	—
BY	local variable	—	—	—	—	U	—	—	—	—	—	—	—	—	—	S	—	—	—	—	U	U	—	—	—	—
ONE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—
P	local variable	—	—	—	—	B	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	B	—
PI	common block	U	—	—	—	—	—	—	—	—	—	—	—	—	S	U	—	U	—	U	—	—	—	—	—	—
PIX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B
PW	array	U	—	U	—	S	—	—	—	—	—	U	—	—	—	—	—	—	—	U	—	C	—	—	—	—
POW	array	—	—	—	—	—	—	—	B	—	—	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—
PSX	common block	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—
PVAR	virtual array	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Q	virtual array	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
QE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—
QM	local variable	—	—	—	—	—	—	—	S	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
QS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—
QW	local variable	B	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	array	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	A	U	—	—	—	O	—	—	—
RANGE	common block	—	—	—	—	—	—	—	A	—	—	C	—	—	S	—	—	—	—	—	—	—	—	—	—	—
RATE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—
RCON	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RDEL	local variable	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—
RE	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—
REF	common block	—	—	S	—	—	—	—	A	—	—	—	—	—	—	—	S	—	—	—	—	—	U	U	—	—
RGAIN	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	A	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	DPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	[illegible]	Update Input	Channel	Interpolator	Recon Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
RGLB	common block	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RIBS	common block	—	—	—	—	U	—	U	—	—	—	A	S	U	S	—	A	C	U	U	—	—	U	—	—	—
RJBS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
RKAL	local variable	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—	—
RKBS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
RKIBS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	B	—	—	—
RKIPS	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	—	—	—
RMAX	local variable	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RMBS	common block	—	—	—	—	—	—	—	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—
RNEXT	local variable	—	—	—	—	—	—	—	—	—	—	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RNUM	common block	U	—	—	—	—	—	—	—	—	—	—	—	—	S	—	S	B	—	U	—	—	U	C	—	—
RS	array	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RSR	common block	—	—	—	—	—	—	—	A	U	—	U	—	U	—	U	—	—	—	U	—	—	—	—	—	—
RSYNC	array	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RTHOLD	common block	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—
RW	local variable	B	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S	virtual array	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	U	—	—	—	—	—	—
S	array	—	—	—	S	—	—	U	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SBAR	array	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SCALE	local variable	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
SDC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—
SI	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—
SIGMA	local variable	—	—	—	—	—	—	S	—	—	—	—	—	—	—	S	—	U	—	—	—	—	—	—	—	—
SINC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	—	—	—	—	U

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	BPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	DFES	INITIALIZE PARAMETERS	Update Input	Channel	Interpolator	Noise Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC	SINC
SINK	array	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	D	—	U	—	—	—	—	—	—	—
SIX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—
SKIP	common block	—	—	C	—	—	—	—	B	—	—	—	—	—	—	—	—	U	—	U	—	—	U	U	—	—
SMODE	local variable	—	—	—	—	—	—	—	—	—	—	S	—	—	—	B	U	U	U	U	—	—	—	—	—	—
SNR	common block	—	—	—	—	—	—	U	D	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—
SNRM	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	D	—	—
SPAW	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	B	—	—	—	—	—	U	—	—
SPOW	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	B	—	—	—	—	D	U	—	—
SQ2	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	U	—	U	—	—	—	—	—	—
SR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—
SUM	local variable	—	—	—	—	—	—	—	—	—	B	B	—	—	—	—	—	—	—	—	—	—	—	—	B	—
SUM1	local variable	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SVAR	local variable	—	—	—	U	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—
TEMPF	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—
TI	common block	—	—	—	—	—	—	—	S	—	—	D	—	—	S	—	O	—	—	—	—	—	—	—	—	—
TOP	local variable	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TSR	common block	—	—	—	—	—	—	U	A	—	—	—	—	—	—	U	—	—	—	—	—	—	—	U	—	—
V	array	—	—	—	—	—	—	—	D	—	—	—	—	—	S	—	—	—	—	A	—	—	—	—	—	—
VIN	virtual array	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—
VKAL	array	U	—	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
VMAX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	B	—	—	—	—	—	—
VR	array	—	—	—	—	—	—	—	—	—	—	—	S	—	—	—	—	U	—	—	—	—	—	—	—	—
VSTEP	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

SUBROUTINES															SUBPROGRAMS										FUNCTION SUBROUTINES	
VARIABLE COMMON BLOCK ARRAY		BFLIT	BPGEN	FWATE	GAURAN	KEY	MAX	NOISE	PARIN	PIN1	SEMUL	SYNC	TAPER (READ)	TAPER (RGEN)	* DFES	[illegible] PARAMETERS	Update Input	Channel	Inter-polator	Norm Filter	Forward Filter	Compressor	Detector	Differential Decoder	ERFC , SINC	
W	array	—	—	B	—	—	—	—	3	—	—	B	—	—	S	—	0	—	—	—	U	—	—	0	—	—
WMAX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—
WMULT	local variable	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	virtual array	—	—	U	—	—	—	—	—	—	—	U	—	—	—	—	—	—	B	A	U	—	—	—	B	—
X	local variable	—	S	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U
XC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—	—	—	—	—	—
XERR	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—
XF1	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
XF2	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—
XFREQ	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	A	—	—	—	—	—	—
XKSET	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XX	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—
Y	array	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	C	—	—	—	—
YC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—
Z	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	U	0	U	—
ZC	local variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	B	0	—	—
ZERO	local variable	—	—	—	—	—	—	—	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

PRECEDING PAGE BLANK-NOT FILMED

FILMED